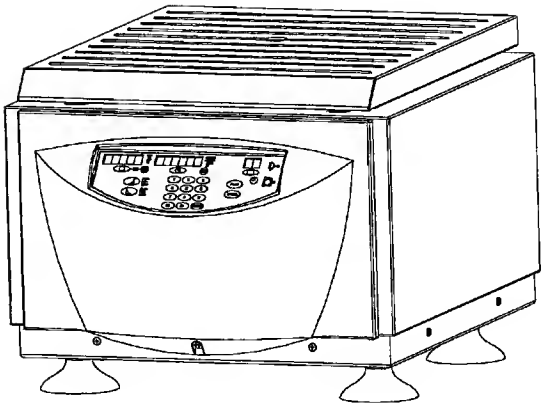
SERVICE MANUAL
SM8464

Revision 0



Multi (RF) Series
Multipurpose Centrifuge

Multi Ventilated Centrifuge
Cat. No. 8464 -- 120 VAC, 60 Hz
Cat. No. 8465 -- 220, 230, 240 VAC, 50/60 Hz

Multi-RF Refrigerated Centrifuge
Cat. No. 8466 -- 120 VAC, 60 Hz
Cat. No. 8467 -- 220, 230, 240 VAC, 50 Hz
Cat. No. 8468 -- 220, 230, 240 VAC, 60 Hz

Printed in the USA

Table of Contents

1 Introduction

1.1 General Product Description

Multi_series units are high-speed, multi purpose centrifuges, used in medical, industrial, and scientific applications.

The Multi Series is available in two models: ventilated (Multi) and refrigerated (Multi RF). Sections of this manual that apply to the refrigerated version will be designated Multi RF or refrigerated only.

Both models accommodate swinging bucket or fixed angle rotors. They can process a variety of tubes, bottles, and microsample tubes. Swinging bucket styles include a 4 x 250 mL and microplate carrier rotor. The microplate rotor can process both standard and deepwell microplates. Fixed angle styles include a 6 x 85 mL, an 8 x 50 mL, and a 48-place microbe rotor.

Each centrifuge has an easy to use front panel that provides two modes of operation: **Manual** and **Programmed.**

Manual mode is used for entering temperature (Multi RF only), speed/force, and time values for individual runs.

Program mode allows you to define and save a maximum of ninety-eight specific sets of run parameters, to recall and reuse.

The Multi Series features a maintenance-free, brushless motor, and an easy-to-use front panel, which provides five versatile timing modes: At Start, At Speed, Hold (continuous), $\int\omega^2 dt$ (centrifugal integrator) and Pulse (momentary). Acceleration and brake rates may be controlled, to optimize runs: rapid for fast separations or slow for delicate samples. Repeat runs, with the same speed and time settings, may be achieved at the touch of a key.

A fail-safe cover interlock ensures that the cover is closed, before a run can begin, and keeps the cover closed, until the rotor has reached a safe low speed (below 100 rpm), even in the event of a power failure.

The rugged steel cabinet and rigid construction provide quiet operation and long term reliability.

1.2 About This Manual

The Operations Manual contains all of the information needed to install, operate, and maintain a Multi Series centrifuge. Refrigerated and ventilated models operate, and any differences are highlighted and noted, throughout this manual. This manual, also, contains derating, chemical resistance, and decontamination tables. The last chapters the units' specifications.

This manual is written for centrifuge operators. In addition to operation information, it contains a few basic troubleshooting techniques, and a chapter on maintenance. This **Operation Manual** is not a guide for servicing centrifuge units.

1.3 Warnings, Cautions, and Notes

The terms **warning**, **caution**, and **note** have specific meanings in this manual.

- A **Warning** advises against certain actions or situations that could result in personal injury.
- A **Caution** advises against actions or situations that could damage equipment, produce inaccurate data, or invalidate a procedure.
- A **Note** provides useful information regarding an operation, function, or procedure.

2 Installation

2.1 Receiving the Unit

IEC ships the centrifuge in a carton that protects it from shipping hazards. Follow the unpacking instructions on the carton. Be sure to complete and return the postage-paid warranty card, or register your warranty at our website: www.labcentrifuge.com.

2.2 Site Preparation

The unit normally resides on a bench top. The Multi (ventilated model) can be placed in a cold room (no colder than 4°C), for processing temperature-sensitive samples. When you remove the centrifuge from a cold environment, do not operate for a minimum of two hours, so that any condensation will evaporate.

Note: When used in a cold room environment, some bearing noise may become evident. The bearing lubricant thickens at low temperatures. As the centrifuge speeds up, it is thinned and

distributed more evenly. Once this occurs, the centrifuge should operate more quietly.

The following table lists the physical dimensions for the Multi and Multi RF:

	Multi RF	Multi
Sample Loading Height	13.9" (35.3 cm)	14.3" (36.3 cm)
Cover Closed Height	15.8" (40.0 cm)	15.8" (40.0 cm)
Cover Open Height	35.8" (90.8 cm)	36.3" (92.1 cm)
Width	30.8" (78.1 cm)	20.5" (52.1 cm)
Depth	25.8" (65.4 cm)	25.8" (65.4 cm)

A clearance of 8 cm (3 inches) should be provided on each side of the unit, to ensure proper ventilation. Place the centrifuge on a clean, dry surface, to make certain that the suction feet at the bottom grip the surface firmly. Keep the area beneath the unit free of debris and loose materials.

The resting surface must be level, to ensure quiet, vibration-free operation. A rigid and stable location is important. An improperly loaded centrifuge may vibrate or move.

Warning: International Electrotechnical Commission standard 1010 part 2-20 limits the permitted movement of a laboratory centrifuge to 300 mm (12 in) in the unlikely event of a disruption. Laboratory management procedures should require that no person or any hazardous materials enter within this boundary while the centrifuge operates.

2.3 Power Configuration

The Multi Series uses AC power in different configurations, appropriate for use throughout the world. Please check the catalog number of the model that you have purchased, to ensure that the machine you have is the proper power configuration. For best results, the refrigerated centrifuge, Multi RF, should be used on a dedicated line. Variations in line voltage or frequency affect the unit's speed and other characteristics. Under extreme low line conditions, the circuit breaker may trip as the centrifuge attempts to reach maximum published specifications of speed and/or temperature. Power line voltage, at some locations, may sag, when the refrigeration system turns on.

Power Cord

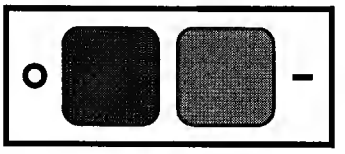
The unit requires a grounded power supply (3-prong outlet). If your facility does not have grounded power outlets, arrange for a proper grounding. The power cord plugs in on the left side of the unit.

Warning: Do not remove the grounding pin from the centrifuge power cord. Do not use the bare wired power cord to attach a power plug that does not have a grounding pin.

The power cord provided with the unit is correctly rated for the highest current demand. This power cord should not be interchanged with cords from equipment with lower current demand. Exchange of power cords between equipment may create a fire hazard.

Main Power Switch

The main power switch is located on the left side of the centrifuge next to the power cord. Press the green button to power the unit on, and the red button to power the unit off according to the picture below:



OFF (Red) **ON (Green)**

Circuit Breaker

The system provides an automatic circuit breaker for Emergency situations, such as power surges, that could damage the unit. The breaker is integral to the power switch. When tripped, the red (power off) button will protrude from the power switch.

If the circuit breaker trips, press the green button in the power switch to reset the breaker.

2.4 Moving the Unit

Suction cups, at the bottom of the unit, keep it anchored to the work surface. Keeping the unit stationary is a safety feature.

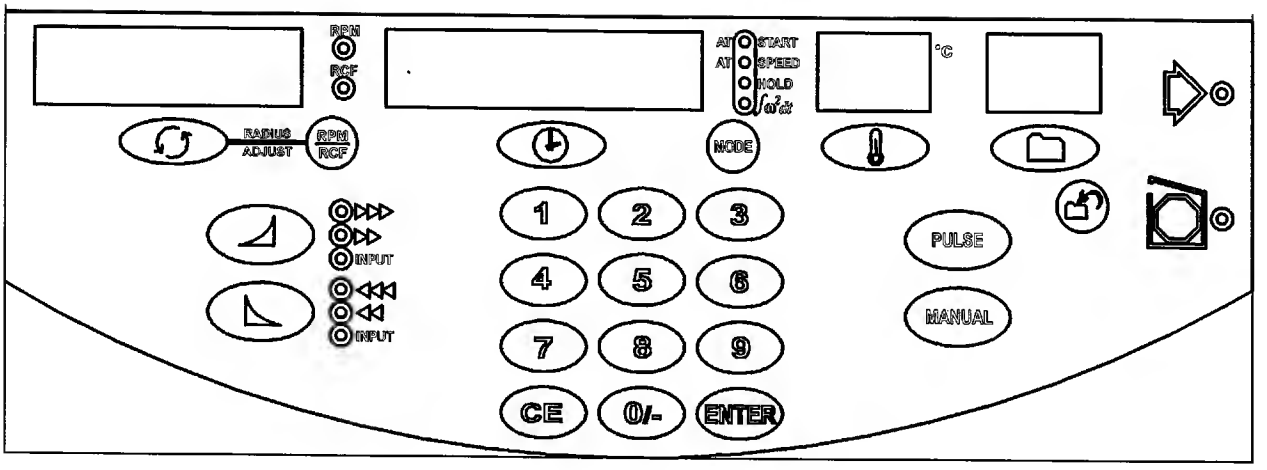
To move the unit to a new location:

Caution: The unit can weigh up to 254 lb. (116 kg). Use precaution when moving to avoid any injury.

1. Check that the new site meets the criteria in Section 2.2 before moving the unit.
2. Position a flat object, such as a tongue depressor, near a suction cup at the bottom of the unit.
3. Lift up an edge of the cup, and insert the flat object far enough to break the vacuum seal.
4. When all four cups are disengaged, lift the unit from the work surface.

Caution: When the unit is in its new location, ensure that the suction cups adhere correctly to the work surface.

2.5 The Front Panel



The Front Control Panel
(Multi RF Model Shown)

The control panel contains numeric displays for RPM/RCF (Speed/Force), Time, program, and Temperature (Refrigerated only). These displays have two states or modes: Actual (bright display) and Set (dim display).

In Actual mode (bright display), they indicate current run conditions, such as:

- Rotor speed or force
- Elapsed time of, or time remaining in, the run
- Actual temperature (Refrigerated only)
- Program number

In Set mode (dim display), the display indicates the desired settings for the run. Set mode is activated when:

- SPEED, TIME, TEMP., or PROGRAM are pressed
- Briefly, at the start of a run
- Briefly, after the unit is switched **ON**

The numeric displays can, also, display warning or error messages (see Section 3.7). Descriptions of the displays appear on the following pages.

Speed Key: Pressing the SPEED key switches the display from Actual to Set mode. Select the desired speed using the numeric

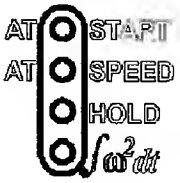
keypad, and then press ENTER. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

RPM/RCF key and display: The number in the speed/force display represents the rotor speed in RPM or force in RCF. Indicator lights to the right of the display identify which display mode is active. Press this key to toggle between RPM and RCF. When RPM is selected, the display indicates revolutions per minute. When RCF is selected, the display indicates relative centrifugal force. Use the numeric keys to change the set speed or force. Select speed in increments of 50 RPM, from 500 through 16,800 RPM (depending on the max. allowable speed limit for the particular rotor). Select RCF from 500 - 30,600 xg (depending on the max. allowable RCF limit for the particular rotor) in increments of 50 xg.

RADIUS ADJUST: Pressing the SPEED and RPM/RCF keys (located on either side of this symbol) together allows the user to change the radius of rotation. Select the radius using the numeric keypad, and then press ENTER. Also see Section 3.4 Rotor Recognition System.

Time key: Pressing the TIME key switches the display from Actual to Set mode. Select the desired time using the numeric keypad, and then press ENTER. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

Time display mode: Pressing the MODE key switches the time display mode. Time is displayed as hours:minutes:seconds up to 99 hours, 59 minutes, 59 seconds, except in the Integrator mode (see below).



AT START: The timer starts counting down as soon as START is pressed. The run will end once the set time expires.

AT SPEED: The timer starts counting down as soon as 100% of set speed is reached. The run ends once the set time expires.

HOLD: The hold feature is used to initiate an indefinite spin. Pressing START will then begin a run at the set parameters. The timer will count up, and the run will not end until the STOP key is pressed.

***∫ω²dt*:** The Speed Squared Integrator feature is used to exactly replicate repetitive runs. Accumulated centrifugal effect is displayed in scientific notation, as X.XXX YY where X.XXX is the coefficient and YY is the exponent. For example, a display of 9.999 12 equals 9.999×10^{12}. Values between 2.750×10^{3} (minimum) and 9.999×10^{12} (maximum) can be input." See

Section 3.5 for a more detailed explanation.

PULSE: The PULSE feature is used for quick separations. Pressing PULSE will begin a run at the set parameters. The timer will count up, and the run will not end until the PULSE key is released.

Temperature key: Pressing the TEMP key switches the display from Actual to Set mode. Select the desired temperature using the numeric keypad, and then press ENTER. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

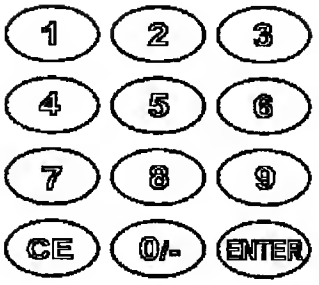
Temperature display: The number in the display represents temperature in degrees Celsius, from – 9 °C through + 40 °C.

Note: If the Actual rotor chamber differs by more than 5°C from a selected set point temperature, the °C display will switch between the actual and set/programmed temperatures, until the two temperatures come within 5°C.

Program key: Pressing the PROGRAM key switches the display from Manual to Program mode.

Save key: This key saves the currently displayed desired settings as stored programs 1 through 99 (98 on RF models). See Section 3.3 for more detailed instructions. The numeric display shows the stored program number and mode of operation (see Section 3.2).

MANUAL key: The manual returns the unit to manual operation from Program mode.



Numeric Key Pad: The numeric keypad is used to change the Set parameters for Speed/Force, Time, Temperature (Refrigerated only) Radius, or Program. When any of the mode keys such as the SPEED, TIME, TEMP or PROGRAM key is pressed, the numeric display switches from Actual readings to Set parameters, without changing them. The numeric keypad may be used to change the parameter value. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

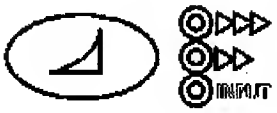
The CE key is used to clear a selection that has not yet been entered to memory.

The 0/- key may be used to select a negative temperature. Note: Temperature control range is specified from +4 °C to ambient at maximum rated speed. Lower temperatures can be achieved at less than maximum speed.

The ENTER key *must* be pressed after each parameter selection to enter the value into memory.

Acceleration and Braking

Gentle acceleration and braking can be selected, when centrifuging delicate samples. The gentle settings avoid mixing of density gradients or breakup of pellets.



Acceleration key: The Acceleration key controls rotor acceleration up to 400 RPM. Press this key to select from the following acceleration modes:

- Fast acceleration is selected when the indicator next to ▶▶ is lit. Fast acceleration applies full acceleration until the set speed is reached.
- Slow acceleration is selected when the indicator next to ▶ is lit. Slow acceleration takes from 15 to 35 seconds to achieve 400 RPM, depending on the rotor and its contents. After 400 RPM, full acceleration is applied, until the set speed is reached.
- The **INPUT** selection allows the user to select the speed at which acceleration switches from slow to full. Once the indicator light is illuminated for this mode, the speed display will indicate the speed at which full acceleration will be applied. Select the desired speed setting (between 50 - 800; default 400), and then press ENTER. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

Deceleration key: The Deceleration key controls rotor braking. Press this key to select from the following deceleration modes:

- Fast braking is selected when the indicator next to ◀◀ is lit. Fast deceleration applies full brake from 12,000 rpm until zero speed is reached (coast above 12,000).
- Slow braking is selected when the indicator next to ◀ is lit. Slow deceleration applies full brake until 400 rpm and then coasts until zero speed is reached.
- The **INPUT** selection allows the user to select the speed at which braking switches from full to coast. Once the indicator light is illuminated for this mode, the speed display will indicate the speed at which coast will be applied. Select the desired speed setting (between 50 - 800; default 400), and then press ENTER. A selection must begin before 5 seconds elapse or the display will revert to the Actual reading.

- When no indicators are lit, coast (no brake) is selected. The rotor will coast from operating speed to a stop.

The START key starts a run. A run is governed by the Set parameters (manual or programmed). The green indicator light blinks, until the rotor reaches 95% of the set run speed. The light stays on until the end of the run.

This STOP/OPEN COVER key stops a run or unlocks the cover when the unit is not running. (A run will also stop automatically when the set time has elapsed or the PULSE key is released, in the PULSE mode.) The red indicator light flashes to indicate the rotor is still slowing down (braking or coasting). When the run ends, the red light stays on, indicating that the rotor has stopped.

3 Operation

3.1 Rotor and Accessories

A balanced load is essential for all centrifuges. An unbalanced load produces vibration, and can damage the unit. A 2-gram load imbalance, at a speed of 4600 RPM, imparts force equivalent to 9.1 kg (20 pounds) at rest. Always ensure that the rotor is loaded symmetrically, with a full complement of accessories, and a full (or paired) set of tubes. Tube adapters should also be installed symmetrically.

The rotors are dynamically balanced at the factory. The manufacturer matches removable parts (trunnion rings, shields, buckets, and carriers) to within 1 gram, and stamps the weight on each piece. Check these markings, whenever you interchange parts, to ensure that opposite parts are matched. Ensure that the total weight of samples and removable parts, loaded in opposing positions, are equal in weight, to within 1 gram. The position numbers, present on many rotors and adapters, identify opposing tube positions.

To obtain good dynamic balance, opposite loads must not only be equal in mass, but must, also, have the same centers of gravity. Opposing containers must be alike in shape, thickness, and distribution of glass or plastic. This is especially important for large containers.

Tubes loaded into swinging bucket rotors must be symmetric, around the axis of rotation. Verify this by rotating the entire rotor 180°, by hand. The loads should be in the same apparent positions (not mirror images). In addition, the loads within each bucket must, also, be symmetric around the bucket's pivot axis. Verify this by ensuring that each bucket is loaded so that it does not tilt from the vertical, when the rotor is at rest. Maintaining balance within each bucket ensures that the bucket and the tubes swing out to horizontal, when the rotor reaches operating speed, applying centrifugal force toward the bottom of the tubes. Failure to achieve full swing-out causes vibration and premature wear of the rotor and the motor.

Samples of like (similar) specific gravities may be processed in the same run, provided that the samples of the same type are balanced around the rotor, as though they were the only pairs in the rotor.

Caution: Do **not** exceed maximum rated speed for each rotor/accessory combination. Maximum rated speeds can be found in Section 4.2 - **Speed and Force Tables**.

Rotor Balance

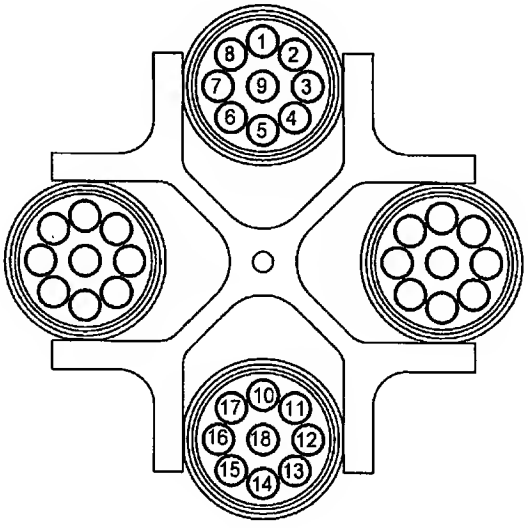
Load tubes in the following manner:

1. Load two tubes at positions:
   9 and 18.

2. Load four tubes at positions:
   1, 5 and 10, 14
   or
   7, 3 and 16, 12

3. Load six tubes at positions:
   1, 9, 5 and 14, 18, 10
   or
   7, 9, 3 and 12, 18, 16

4. Loading an odd number of tubes is not



recommended.	

Vibration

All centrifuges have critical speeds, at which vibration occurs. As the speed increases, beyond the critical speed, vibration will cease. This inherent condition, also, occurs during deceleration. An imbalanced load intensifies these critical vibrations. **Do not continuously operate this centrifuge at observed critical speeds.**

Rotor Installation

To install the rotor:

1. Place the rotor (with recognition ring facing down and all printing facing up) onto the shaft.
2. Using the wrench provided, tighten the locking nut until its spring washer is firmly flattened. Slide the wrench handle to one side in order to utilize maximum torque. Remove the wrench.
3. Place the cover onto the rotor (fixed angle only) and, using the knob in the center of the cover, turn it clockwise to tighten it.

Note: It is important to use the cover on the fixed angle rotors. This cover cuts down on aerodynamic noise and windage, enabling the rotor to achieve maximum specified speed, with minimal noise levels. It also provides aerosol containment.

Note: Fixed angle rotors must be fully seated on the drive shaft, so that the drive pin engages the slots in the bottom of the rotor.

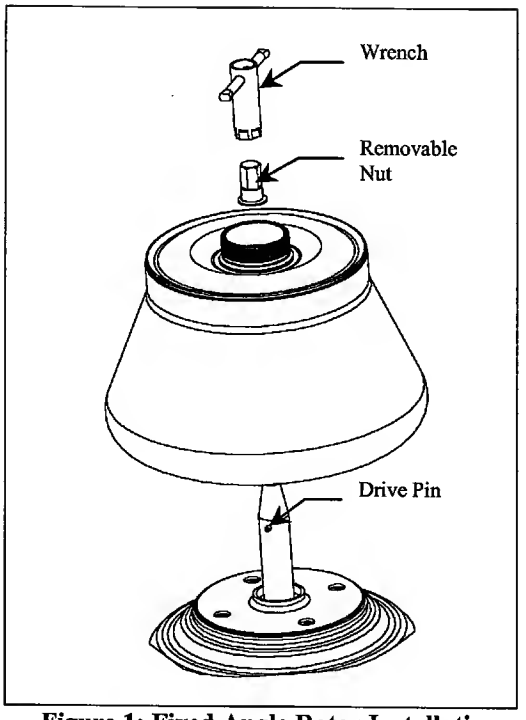


Figure 1: Fixed Angle Rotor Installation

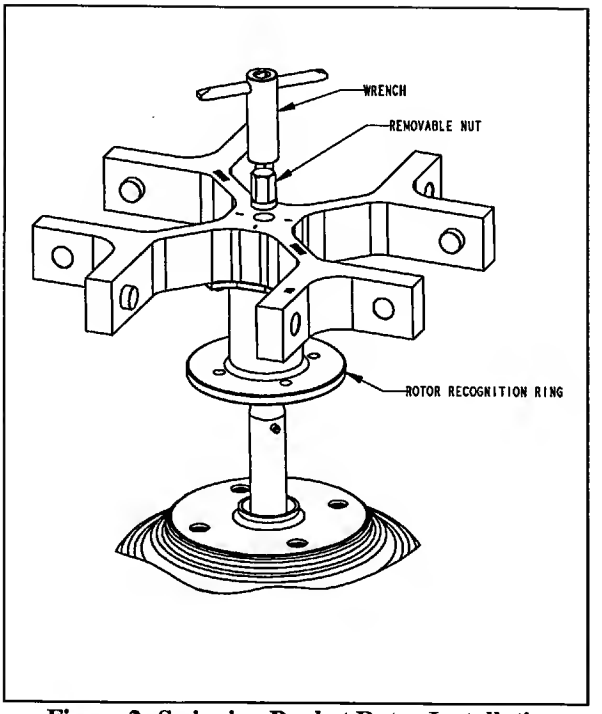


Figure 2: Swinging Bucket Rotor Installation

Rotor Removal

To remove the rotor:

1. Using the wrench provided, loosen the rotor-locking nut. Remove the wrench.
2. Remove the locking nut.
3. Lift the rotor off the shaft.

3.2 Starting and Stopping a Run

Read Section 2.5, for a general description of the front panel. The settings displayed on the front panel always govern the operation of the unit. The display above the Program key shows the unit's operating mode. It is important that the unit be in the correct mode for the desired operation.

The PROGRAM display can be one of the following:

- Blank The unit is in **manual operation.**
- 1-99 The unit is under control of the displayed **stored Program** number. (1-98 RF only)
- C Rapid Condition, program 99. (RF only see section 3.6)

The rest of the display indicates the last parameters selected.

Manual Operation

For manual operation, press the MANUAL key so that the program display is blank. Select the desired temperature (Multi RF only), speed/g-force, run time, acceleration mode, and braking mode. Select the desired Timing Mode from the following:

- **At Start:** The timer starts counting down as soon as START is pressed.
- **At Speed:** The timer starts counting down as soon as 100% of set speed is reached.
- **Hold:** The timer will count up, and the run will not end until the STOP key is pressed.
- $\int\omega^2 dt$: The accumulated centrifugal effect will count up as soon as START is pressed. See Section 3.5 for more detailed instructions.

Press **START**, to start the spin.

The rotor will accelerate to 100 - 200 rpm and then coast for a few seconds while the rotor recognition system verifies the rotor and set parameters.

The time display counts according to the timing mode selected. The spin will stop automatically, at the end of the desired interval, except in the Hold mode. A run can, also, be stopped, at any time, by pressing the **STOP** key.

The settings can be changed during a manual run. These changes affect the run in progress. If the time setting is changed, during a run, the unit adjusts the countdown timer, to display the revised setting as the total time of the run. If the new time selected is less than the elapsed time, the run will end.

The unit's mode (settings) cannot be changed during a program mode spin.

3.3 Stored Programs

The Multi Series has an internal memory capable of holding 99 (98 only RF models) sets of run parameters. Each set, or program, is stored and can be recalled by selecting a program number. Programs are retained in memory, even if the power is turned off. When necessary, a program can be modified for a particular run or changed permanently. You **cannot** change the unit's program, rotor/radius, or timing modes, during a spin.

Add/Change Program

Press PROGRAM to enter Program mode.

Select a program number with the numeric keypad. The current program parameters will appear on the display.

Modify the desired parameter, including speed/RCF, time, and temperature (if a refrigerated unit), using the numeric key pad or modify the ACCEL or BRAKE modes. Additionally, a radius value may be stored explicitly in the program. The program number will flash, indicating that the program was changed and has not yet been saved.

Make the changes permanent by pressing the SAVE key. The program number will stop flashing, and the new program settings will be displayed. The program will remain in memory until further changes are made.

Because the Multi (RF) has a fully automatic rotor recognition system, the very first rotor that is spun using a particular program will be identified and have its identity automatically stored in the program. If the user does not explicitly set a radius value, the

default radius (or maximum allowable radius) for that rotor will be stored with the program as well. If the user attempts to run a rotor other than the one whose identity is stored in the program, a "ch hd" (check head) message will appear.

If the user wishes to clear the rotor and its radius from the memory banks of the program, he or she need only press the SAVE button. The very first rotor spun after SAVE is pressed will have its identity stored in the program, together with its default radius (if not explicitly entered to the program).

To make changes temporary, press START without pressing the SAVE key. The program display will flash, to indicate that the instrument is not currently operating from program mode. The original program will remain unchanged as long as the SAVE key is not pressed.

Recall Program

Press the PROGRAM key to enter program mode. Select the appropriate program number by entering the desired program number on the numeric keypad and press ENTER.

The program's set parameters will be displayed. Press **START** to begin this run.

Lock Program

Programs can be locked by selecting the desired program on the numeric keypad, and pressing the **SAVE** key three times. When you scroll to a locked program, the letter **L** will flash in the program display, after the program number is displayed. To unlock a program, select the desired locked program on the numeric keypad and press the **SAVE** key three times. Parameters of locked programs cannot be changed.

3.4 Rotor Recognition System

The Multi (RF) is equipped with a fully automatic rotor recognition system that internally detects and identifies the rotor installed. Since the Multi (RF) was designed to spin a variety of rotors, its software database contains the maximum settable values for speed, RCF, and radius for each. This enables the centrifuge to check and ensure that these parameters as entered by the user do not exceed the prescribed safety limits for the specific rotor.

If a user has input a value for speed, RCF, or radius that exceeds the specified limit, the control panel will display a message and the unit will coast to a stop. Below is a table of condition and the corresponding message that will appear in the speed display window:

Condition	Message
Input Speed value exceeds maximum allowable	"SPD" toggled with the max. allowable speed setting for the rotor
Input RCF value exceeds maximum allowable	"rCF" toggled with the max. allowable RCF setting for the rotor
Input Radius value exceeds maximum allowable	"RAD" toggled with the max. allowable radius setting for the rotor
No Rotor Installed	"HEAD"
Rotor Installed but incomplete or no rotor signature is read	"HEAD"
Faulty Rotor Recognition System	"HEAD"
Incorrect rotor signature is read (i.e. does not correspond to one in the software database)	"ch hd"

To clear an error message relating to rotor recognition, the user must press one of the following buttons:

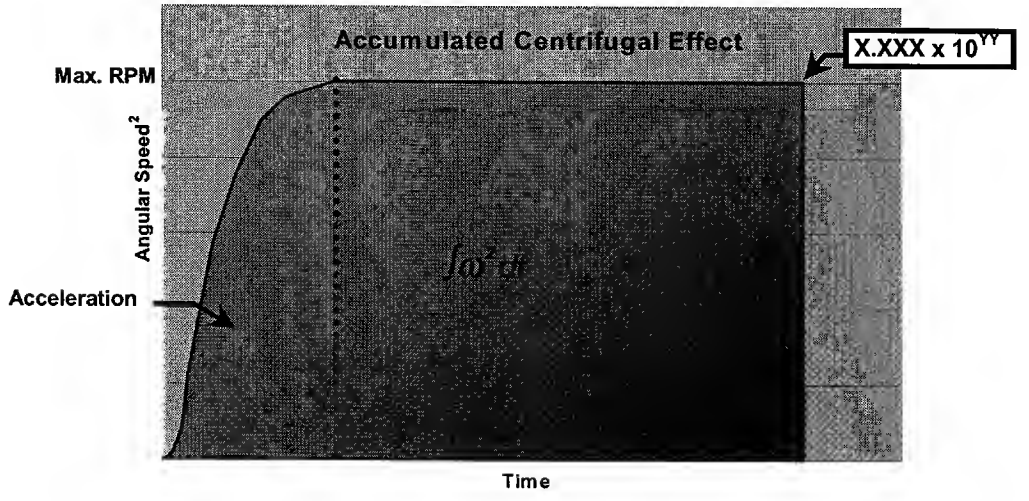
- STOP
- Power Switch (on the side of the unit)

3.5 Speed Squared ($\int\omega^2 dt$) Integrator

The Speed Squared ($\int\omega^2 dt$) Integrator calculates the total accumulated centrifugal effect experienced by the sample. This feature can be used to precisely replicate runs, achieving the same amount of applied g-force from run to run.

The Integrator eliminates the need to estimate acceleration times to meet a particular protocol. For example, if a sample requires a 10-minute run at 5,000 RPM to achieve separation, and it takes an unknown amount of time to accelerate to 5,000 RPM, the Integrator would allow you to avoid doing test runs to determine the acceleration times. This can be particularly handy if your sample volume varies from run to run, since a change in sample volume can vary the acceleration time.

Note: The Integrator includes the centrifugal effect applied during acceleration, and at speed, but does not account for the effect during deceleration.



To use the Integrator, calculate the centrifugal effect using the following formula:

$$\omega^2 dt = \left[\frac{RPM}{60} \times 2\pi\right]^2 \times (t_2 - t_1)$$

Where RPM is your speed, and (t_2 - t_1) is the run time in seconds.

For our previous example of 5,000 RPM for 10 minutes, the result would be 164,493,406 or 1.645×10^{08}. To enter this value into the centrifuge's Integrator, press the MODE key until the light next to

the $\int\omega^2 dt$ is illuminated. Then press 1-6-4-5-0-8, so that the display shows 1.645 08. Accumulated centrifugal effect is displayed in scientific notation, as X.XXX YY where X.XXX is the coefficient and YY is the exponent. A display of 1.645 08 equals 1.645×10^{08}.

3.6 Refrigeration (Multi RF only)

Refrigerated units refrigerate the rotor chamber whenever the cover is closed and the unit is switched on. Refrigeration is applied, as necessary, to cool the rotor chamber to the currently displayed temperature setting. If you use the keypad, and momentarily display a cold temperature (stepping through stored programs, for example), refrigeration will not be activated.

If the rotor chamber is not at the specified temperature, it will not abort the spin. However, if the rotor chamber differs, at the start of a run, by more than 5°C, from the specified temperature, the °C display will switch between the actual and set/programmed temperatures, until the two temperatures come within 5°C. Press the **STOP** key, if the run should not continue at the actual temperature.

The unit is not designed for use as a refrigerator. The natural fanning action of the rotor serves to maintain a uniform temperature distribution inside the chamber. At zero RPM, there is no correlation between set and actual chamber temperatures.

Any frost or condensation that forms in the rotor chamber should be removed. Allow it to melt, and remove it with a sponge or cloth. When the centrifuge is not in use, turn it off, or leave the cover open (to disable refrigeration).

Rapid Condition

When the chamber temperature is above the set temperature, Rapid Condition will run a rotor at 500 rpm, to increase air circulation in the chamber, quickly cooling the chamber to the set point. When the chamber temperature is below the set temperature, Rapid Condition will run the rotor at 4000 rpm, to warm the chamber to the set temperature. When the temperature has been reached, three beeps will sound, and the rotor will brake

to rest. Some smaller rotors may not be able to warm the chamber to higher temperature settings.

Program

To use this program, first select the protocol that will be run immediately after the desired temperature is reached (for example, to select program #1, press the Program key, press '1' and then ENTER). Next, press the Program key, and select program #99 (Rapid Condition) by pressing 9-9-ENTER. A 'C' appears briefly in the program number display, followed by the number 99. Rapid Condition automatically uses the last value stored in the temperature setting. Press the **START** key to begin the Rapid Condition program. Upon completion, the display will revert back to the last program displayed prior to entering program 99.

3.7 Diagnostic Messages and Error Codes

The beeper sounds in these situations:

- Two times on power up.
- Three times at the end of a spin.
- Five times when a warning occurs

Diagnostics Diagnostic messages appear in place of the speed display, in the following cases:

Message	Description
bAL	**bAL** indicates an unbalanced rotor. Open the cover, to erase this message. Verify that a balanced load is installed. Inspect the rotor, and rearrange the tubes, or add additional tubes, with fluid, to balance the rotor.
HEAd	**HEAd** appears if either of the following occur: No rotor is installed when START key is pressed. Recognition system fails to read a valid rotor (due to improper rotor or a faulty recognition system). Press **STOP**, to erase this message.
ch hd	Change Head. The rotor recognized is not in the list of supported rotors, or, in Program mode, current Program is set up to run with a different rotor. Press **STOP** to erase this message, open the cover, and install the appropriate rotor.
LId	**LId** appears if you press the START key, when the cover is not closed. Close the cover, to erase this message.
PFAIL	**PFAIL** indicates that power was interrupted during a run. This message appears when the unit is turned back on, following the failure. The front panel will alternate between the PFAIL message and the remaining run time, or elapsed time, if in Hold mode. Press **STOP,** to erase this message. Press **START**, to resume the previous run.
rAD	**rAD** appears (and flashes with the max. allowable value) if the input radius is greater than the maximum allowable for the rotor detected. Press the **STOP** key to clear this message, and, when in PROGRAM mode, then the **SAVE** key to use the default (max.) radius for the rotor installed. In the **MANUAL** mode, the correct radius must be entered. See Section 3.3, Add/Change Program for instructions on changing the radius.
rCF	**rCF** appears (and flashes with the max. allowable value) if the input RCF is greater than the maximum allowable for the rotor detected. **rCF** can also appear if the entered combination of rCF

	and RAD requires a speed in excess of the maximum allowable for the rotor. The **rCF** value flashing is the maximum allowed with the radius entered. Press the **STOP** key to clear this message. Enter a new RCF value within the max. allowable, or enter a new radius.
SPD	**SPD** appears (and flashes with the max. allowable value) if the input speed is greater than the maximum allowable for the rotor detected. Press the **STOP** key to clear this message. Enter a new speed value within the max. allowable.
COOL	Temp. of Mosfet case exceeds 65 °C. Unit coasts to a stop. Call for service.

Error Codes An error code typically means that the internal microprocessor has detected impermissible readings, or a failure, elsewhere, in the unit. Error messages appear in the speed display. When an error code is displayed, unplug and reconnect the unit to power. If the error code reappears, factory-authorized maintenance may be required. Contact your local IEC representative and tell the service personnel which message appeared, when you report the problem.

Error Code	Description
Err 1	**No Tachometer** Tachometer signals were not present during the run. The rotor coasts to a stop. Cover opening is inhibited, after this error. Unplug and reconnect the unit to power to reset this error.
Err 13	**Stack Error** Memory overflow in the microprocessor. The rotor will coast to a stop.
OSPd	**Overspeed** Speed is 200 RPM above the maximum speed for the installed rotor. The rotor will brake to a stop.
rEFR	**Refrigeration Failure (Refrigerated only)** The unit displays this code, if the measured temperature exceeds 45°C, at any time during the run.
norEF	**No Refrigeration Temp. Sensor (Refrigerated only)** The unit displays this code, if the microprocessor is not detecting a temperature measurement from the temperature sensor.
FSAFE	**Fail-safe Time out** Independent circuitry, on the circuit board, has sensed a lack of activity, from the control microprocessor. All power circuits (including motor, latch, solenoid, etc.) are disabled.
COPF	**Cop Watchdog/OpCode Trap Error** The microprocessor has sensed a lack of activity, from the program that controls the centrifuge. The rotor will coast to a stop.
COP	**COP Watchdog Not Enabled** The microprocessor COP is not enabled. The rotor will coast to a stop.
UndFl	**Undefined Interrupt** The microprocessor was interrupted by an undefined source. The rotor will coast to a stop.
ILLOP	**Op-Code Trap Error** The rotor will coast to a stop
runA	**Run Away Error** The speed detected is higher than the maximum speed of the centrifuge. The rotor will coast to a sop.
dIR	**Wrong Direction of Rotation** The microprocessor discovered wrong direction of rotation, during acceleration
Warnings during a spin: LId, PFAIL, and dIR error messages can occur during a spin. In this case, the rotor brakes or coasts to a stop, and the run ends.	

4 Applications

4.1 Introduction

This section describes the use of specific rotors and accessories. More detailed information is shipped with the rotor or accessory itself. This section contains five reference sections:

- Speed and Force Tables
- Derating Table for Dense Samples
- Chemical Resistance Table
- Decontamination Table
- Nomograph

Caution: Do **not** exceed maximum rated speed for each rotor/accessory combination. Maximum rated speeds can be found in Section 4.2 - **Speed and Force Tables**.

Relative Centrifugal Force (RCF or G-force) at a given speed varies with the rotor, and with the distance away (rotating radius) from the shaft of the centrifuge (center of rotation). The rotating radius is measured to the furthest **inside** tip of the cavity, away from the centrifuge shaft. The Speed and Force Tables indicate the maximum speed and RCF that the Multi (RF) can achieve, with various rotor/accessory combinations. The Derating Table specifies reductions in maximum RPM, when spinning samples with specific gravity above 1.2.

Use of any tube above its rated RCF can cause tube cracking. To avoid this, compare the G forces, specified in the Speed and Force Tables, with the ratings for the tubes that you are using. If the tubes are not rated for the force that the centrifuge will apply, look up their reduced G force, and enter it on the control panel.

Corrosive Solvents

Your centrifuge is made of materials designed to resist immediate attack from most laboratory chemicals. Prolonged exposure should be avoided, by immediately removing the chemical from rotor or assembly. Rotors and accessories placed in the chamber are made of a variety of materials, including aluminum and polypropylene. The Chemical Resistance Table shows the suitability of each material with different classes of reagents.

Section 5.2 describes how to clean and remove corrosion from the chamber, rotors, and accessories. Follow these instructions and clean spills promptly, to minimize the effect of corrosive chemicals and to avoid expensive repairs.

4.2 Speed and Force Tables

Rotor 8244 DoubleDeep™ Microplate Rotor Complete with 2 carriers with cushions and rotor recognition disk					
IEC Cat. No: 8244		**Max RPM:** 4400 **Maximum G-force:** 3050		**Max. Radius:** 14.2 cm	
Tube		**Maximum**		**Radius**	**Cushion**
No. x Vol. (ml)	**Description**	**RPM/RCF**		**(cm)**	**Required**
10 x standard microplate †	86 x 128 mm	4400 / 3050		14.2	Included
Polyfiltronics filtration/ receiver plate assemblies	86 x 128 x 77 mm	4400 / 3050		14.2	Included
2-4xPolyfiltronics deepwell microplate † (single stack) (double stack)	86 x 128 x 43 mm 86 x 128 x 86 mm	4400 / 3050 4400 / 3050/2150		14.2 14.2/9.9	Included Not required

DoubleDeep is a trademark of International Equipment Company

† Check with plate manufacturer for current maximum rating, as IEC Rotor/Accessory combination may exceed that rating.
‡ Bottom plate RCF / Top plate RCF

Rotor 8685 6-Place Sealed Fixed Angle Aluminum, 6x85 mL, 25°

Complete with rotor recognition disk, sealing cover, inner and outer O-rings, but without tube adapters

IEC Cat. No: 8685	**Max RPM:** 15400 **Maximum G-force:** 26250	**Max. Radius:** 9.9 cm

Tube		**Maximum**	**Radius (cm)**	**Tube Adapter** Qty x Cat. No.**
No. x Nominal Vol. (ml) *	**Description**	**RPM/RCF**		
6 x 85 mL sealed	Nalge 38.2 x 105.7 mm #3118-0085	15400 / 26250	9.9	--
6 x 50 mL unsealed	Falcon/Corning Conical † **Without Rotor Cover**	15400 / 24650	9.3	3pr of 6651E
6 x 50 mL sealed	05-529C	15400 / 25450	9.6	3 pr x 6650E
6x35 ml Conical OR	Nalge #3146-0050 ‡	15400 / 24650	9.3	3 pr x 6651N
6 x 30 mL sealed	Corning 8445-30***	15400 / 24900	9.4	3 pr x 6650E *with* Corning 8445-AO
6 x 25 mL sealed	Corning 8446-25***	15400 / 24900	9.4	3 pr x 6650E *with* Corning 8446-AO
6x28-30 ml RB OR sealed	Nalge #3118-0028 ‡ Nalge #3118-0030 ‡	15400 / 25200	9.5	3 pr x 6630E
6 x 15 mL unsealed	Falcon/Corning Conical † **Without Rotor Cover**	15400 / 23600	8.9	3pr x 6650E with 3 pr x 6715
6 x 15 mL sealed	Corning 8441-15***	15400 / 24150	9.1	3 pr x 6650E *with* Corning 8441-AO
6x10 ml	16x75-100 mm***	15400 / 24400	9.2	3 pr x 6650E *with* 3 pr x 7245
6x7ml	13x75-100 mm***	15400 / 24150	9.1	3 pr x 6650E *with*

				3 pr x 7256
6x5ml	10-12x75 mm	15400 / 24150	9.1	3 pr x 6650E *with* 3 pr x 7246
18x1.5/2ml	Microtubes****	15400 / 24900	9.4	3 pr x 6650E *with* 3 pr x 7248

* Tube volume is nominal. Due to rotor angle actual volume is less.
** Adapters 6650E, 6651E, 6651N and 6630E are sold by the pack/2.
*** Check tube manufacturer's ratings for centrifuge compatibility, fitness and required diameter and length support. Although glass centrifuge tubes may physically fit, they should not be expected to withstand maximum rotor performances.
**** Due to variations in microtube cap design which can produce interference fit (long cap loops, wide caps, cap protrusions, etc.), there can be instances when less than three microtubes will fit per adapter.
† Check with tube manufacturer for current maximum rating, as IEC Rotor/Accessory combination can exceed that rating. *Note: Independent testing by IEC of Falcon and Corning tubes have found that these brand tubes with a maximum of 35 ml of fluid sample have been able to perform to the 21000 xg without leaking for 30 minute runs for one use only runs.*
‡ Check with tube manufacturer for current maximum rating, as IEC Rotor/Accessory combination may exceed that rating.

Rotor 8848 48-Place x 1.5 ml Sealed Aluminum Microtube Rotor, 45°
Complete with rotor recognition disk, sealing cover, inner and outer O-rings.

IEC Cat. No : 8848	**Max RPM:** 16800 **Maximum G-force:** 30600	**Max. Radius:** 9.7 cm

Tube		**Maximum**	**Radius (cm)**	**Adapter**
No. x Vol. (ml)	**Description**	**RPM/RCF**	**Outer/Inner**	**Qty x Cat. No.**
48 x 1.5/2 mL	11x44 mm microtube (outer row)	16800 / 30300	9.6	- -
	(inner row)	26500	8.4	- -
48 x 1.5 mL	Amicon Microcon (outer row)	16800 / 30300	9.6	- -
	(inner row)	26500	8.4	- -
48 x 0.7 mL †	B/D Microtainer (outer row)	16800 / 30300	9.6	4 pk x 5763 †
	(inner row)	26500	8.4	
48 x 0.5 mL †	8x32 mm microtube (outer row)	16800 / 30300	9.6	4 pk x 5763 †
	(inner row)	26500	8.4	
48 x 0.4 mL †	6x54 mm Microtube (outer row)	16800 / 30300	9.6	4 pk x 5764 †
	(inner row)	26500	8.4	
48 x 0.25 mL †	6x32 mm Microtube (outer row)	16800 / 30300	9.6	4 pk x 5764 †
	(inner row)	26500	8.4	

Adapters 5763, 5764 are sold by the pack/12.

Note: Sealed Rotor complies with the aerosol containment requirements of: OSHA 29 CFR Part 1910.1030 Occupational Exposure to Bloodborne Pathogens; Final Rule dated 12/06/91.

† Note: Due to the high G-forces provided, IEC 5763, 5764 adapters must be used to spin 0.25-0.7 microtubes. The traditional laboratory practice, cutting off the bottom of a 1.5 ml microtube to be used as an adapter for smaller tubes, does not provide sufficient support to the smaller

tubes at these high g-forces. Failure to use IEC 5763, 5764 adapters could result in a tube/rotor mishap not covered under warranty.

Microtainer is a registered trademark of Becton Dickinson Company

Rotor 8850 8-Place 50 ml conical, 25° Aluminum Fixed Angle

Complete with rotor recognition disk, sealing cover, inner and outer O-rings, but without conical tubes.

IEC Cat. No :	8850	**Max RPM:**	15100	**Max. Radius:**	9.9 cm
		Maximum G-force:	25250		
		Cooling RPM:	14700		
		Cooling G-force:	23900		

Tube		Maximum 4°C Max. RPM/RCF RPM/RCF	Radius (cm)	Adapter Quantity x Cat. No.
No. x Vol. (ml)	**Description**			
8 x 50 mL	Conical tube	15100 / 25250 14700 / 23900	9.9	-
8 x 50 mL sealed	Falcon # 2070 Conical †	15100 / 25250 14700 / 23900	9.9	-
8 x 50 mL sealed	Corning # 430522 Conical †	15100 / 25250 14700 / 23900	9.9	-
8 x 50 mL sealed	28 x 103 mm Oak Ridge	15100 / 24450 14700 / 23200	9.6	4 pr x 50546
8 x 35 mL sealed	Nalge conical OR 28.8 x 114.1 mm #3146-0050,3148-0050	15100 / 25250 14700 / 23900	9.9	
8 x 30 mL sealed	Corning # 8445-30 ‡	15100 / 23950 14700 / 22700	9.4	4 pr x 50546 *with* Corning # 8445-AO
8 x 25 mL sealed	Corning # 8446-25 ‡	15100 / 23950 14700 / 22700	9.4	4 pr x 50546 *with* Corning # 8446-AO
8 x 15 mL sealed	Falcon # 2095 Conical †	15100 / 23450 14700 / 22200	9.2	4 pr 6715
8 x 15 mL sealed	Corning # 430052 Conical †	15100 / 23450 14700 / 22200	9.2	4 pr 6715
8 x 15 mL sealed	Corning 8441-15 ‡	15100 / 23450 14700 / 22700	9.2	4 pr x 50546 *with* Corning # 8441-AO

† Check with tube manufacturer for current maximum rating, as IEC Rotor/Accessory combination can exceed that rating. *Note: Independent testing by IEC of Falcon and Corning tubes have found that these brand tubes with a maximum of 40 ml of fluid sample have been able to perform to the maximum rotor speeds published above without leaking for 30 minute runs for one time only runs.*

‡ Check with tube manufacturer for current maximum rating, as IEC Rotor/Accessory combination can exceed that rating.

Rotor 8947 4-Place Swinging Bucket, 4x250ml (Multi-RF Refrigerated Models ONLY)
Complete with 4 buckets and rotor recognition disk, but without Aerocarrier™ Adapters

IEC Cat. No : 8947	***Refrigerated***	**Max. Radius:**	17.5 cm
	5300		
	Max RPM:		
	Maximum G-force: 5500		
	Cooling RPM: 5100		
	Cooling G-force: 5100		

Tube		**Maximum 4°C Max. RPM/RCF RPM/RCF**	**Adapter Radius**	**Aerocarrier Adapter Quantity x Cat. No.***
No. x Vol. (ml)	**Description**			
4 x 250 ml sealed	IEC 2502	5300 / 5200 5100 / 4800	16.5	2 pr x 6558E
4 x 250 ml unsealed	Corning 1260-250, 1280-250 †	5300 / 5200 5100 / 4800	16.5	2 pr x 6558E
4 x 175/225 mL sealed	Falcon 2076/2075	5300 / 5500 5100 / 5100	17.5	2 pr x 6559E
4 x 100 ml sealed	Round bottom, 38x111 mm	5300 / 5450 5100 / 5050	17.3	2 pr x 6557E
4 x 80 ml	Amicon Centricon Plus 80 †	5300 / 5200 5100 / 4800	16.5	2 pr x 6558E
8 x 50 mL sealed	Corning 8240-50 †, IEC 2997	5300 / 5500 5100 / 5100	17.5	2 pr x 6556E
8 x 50 mL sealed	Falcon/Corning conical	5300 / 5500 5100 / 5100	17.5	2 pr x 6560E
12 x 25-30 mL sealed	Universal, 25 x 107mm †	5300 / 4700 5100 / 4350	14.9	2 pr x 6568E
4 x 20 ml	Amicon Centricon Plus 20 †	5300 / 5200 5100 / 4800	16.5	2 pr x 6558E
20 x 15 mL sealed	Falcon/Corning conical	5300 / 5500 5100 / 5100	17.5	2 pr x 6561E
16 x 10 ml sealed	Kova/Urisystem †	5300 / 5500 5100 / 5100	17.5	2 pr x 6561E
32 x 15 mL sealed	16.5x103mm	5300 / 5000 5100 / 4600	15.9	2 pr x 6567E
36 x 10-15 mL sealed	Vacutainer 16x100, 16x125mm †	5300 / 5450 5100 / 5050	17.4	2 pr x 6562E
20 x 14 ml sealed	Falcon 2059 round with cap ‡	5300 / 4700 5100 / 4350	15.0	2 pr x 6563E
36 x 7-10 ml sealed	Vacutainer 16x75,	5300 / 4700 5100 /	15.0	2 pr x 6563E

	16x100mm †	4350		
48 x 5-7 mL sealed	Vacutainer 13x75, 13 x 100mm †	5300 / 5500 5100 / 5100	17.5	2 pr x 6566E
48 x 3-5 mL sealed	Hemogard Vacutainer 13x75 †, 10-12x75 mm, Falcon #2063 †	5300 / 5500 5100 / 5100	17.5	2 pr x 6566E
48 x 1.5/2.0 mL sealed	Microtubes	5300 / 3700 5100 / 3400	11.7	2 pr x 6565E
48 x 0.7 ml sealed	Microtainers	5300 / 3700 5100 / 3400	11.7	2 pr x 6565E and 4 pk/12 5764
48 x 0.5 ml sealed	PCR Microtubes	5300 / 3700 5100 / 3400	11.7	2 pr x 6565E and 4 pk/12 5764
48 x 0.4 ml sealed	Microtubes	5300 / 3700 5100 / 3400	11.7	2 pr x 6565E and 4 pk/12 5763
48 x 0.25 ml sealed	Microtubes	5300 / 3700 5100 / 3400	11.7	2 pr x 6565E and 4 pk/12 5763

Rotor 8947 4-Place Swinging Bucket, 4x250ml (Multi Ventilated Models ONLY)
Complete with 4 buckets and rotor recognition disk, but without Aerocarrier™ Adapters

IEC Cat. No: 8947	***Ventilated***	**Max. Radius:**	17.5 cm
	Max RPM: **5000**		
	Maximum G-force: 4900		
	Cooling RPM: -----		
	Cooling G-force: -----		

Tube		**Maximum**	**Adapter**	**Aerocarrier Adapter**
No. x Vol. (ml)	**Description**	**RPM/RCF**	**Radius**	**Quantity x Cat. No.***
4 x 250 ml sealed	IEC 2502	5000 / 4600	16.5	2 pr x 6558E
4 x 250 ml unsealed	Corning 1260-250, 1280-250 †	5000 / 4600	16.5	2 pr x 6558E
4 x 175/225 mL sealed	Falcon 2076/2075	5000 / 4900	17.5	2 pr x 6559E
4 x 100 ml sealed	Round bottom, 38x111 mm	5000 / 4850	17.3	2 pr x 6557E
4 x 80 ml	Amicon Centricon Plus 80 †	5000 / 4600	16.5	2 pr x 6558E
8 x 50 mL sealed	Corning 8240-50 †, IEC 2997	5000 / 4900	17.5	2 pr x 6556E
8 x 50 mL sealed	Falcon/Corning conical	5000 / 4900	17.5	2 pr x 6560E
12 x 25-30 mL sealed	Universal, 25 x 107mm †	5000 / 4150	14.9	2 pr x 6568E
4 x 20 ml	Amicon Centricon Plus 20 †	5000 / 4900	16.5	2 pr x 6558E
20 x 15 mL sealed	Falcon/Corning conical	5000 / 4900	17.5	2 pr x 6561E
16 x 10 ml sealed	Kova/Urisystem †	5000 / 4900	17.5	2 pr x 6561E
32 x 15 mL sealed	16.5x103mm	5000 / 4450	15.9	2 pr x 6567E
36 x 10-15 mL sealed	Vacutainer 16x100, 16x125mm †	5000 / 4850	17.4	2 pr x 6562E
20 x 14 ml sealed	Falcon 2059 round with cap ‡	5000 / 4200	15.0	2 pr x 6563E
36 x 7-10 ml sealed	Vacutainer 16x75, 16x100mm †	5000 / 4200	15.0	2 pr x 6563E
48 x 5-7 mL sealed	Vacutainer 13x75, 13 x 100mm †	5000 / 4900	17.5	2 pr x 6566E
48 x 3-5 mL sealed	Hemogard Vacutainer 13x75 †, 10-12x75 mm, Falcon #2063 †	5000 / 4900	17.5	2 pr x 6566E
48 x 1.5/2.0 mL sealed	Microtubes	5000 / 3250	11.7	2 pr x 6565E

48 x 0.7 ml sealed	Microtainers	5000 / 3250	11.7	2 pr x 6565E and 4 pk/12 5764
48 x 0.5 ml sealed	PCR Microtubes	5000 / 3250	11.7	2 pr x 6565E and 4 pk/12 5764
48 x 0.4 ml sealed	Microtubes	5000 / 3250	11.7	2 pr x 6565E and 4 pk/12 5763
48 x 0.25 ml sealed	Microtubes	5000 / 3250	11.7	2 pr x 6565E and 4 pk/12 5763

* Adapters with Number Series 65XX are sold by the pair. Adapters 5763, 5764 are sold by the pack/12.

Note: Aerocarrier Adapters comply with the aerosol containment requirements of: OSHA 29 CFR Part 1910.1030 Occupational Exposure to Bloodborne Pathogens; Final Rule dated 12/06/91.

† Check with tube/bottle manufacturer for current maximum rating, as IEC Rotor/Accessory combination may exceed that rating.

‡ Caps have larger diameter than tube and interfere with each should all cavities try to be used. Thus, use only center hole and 12, 3, 6 and 9 o'clock positions in the adapter for a total of 5 tubes per adapter.

Aerocarrier is a trademark of International Equipment Company
Amicon and Centricon are trademarks of Millipore Corporation
Vacutainer and Microtainer are registered trademarks of Becton Dickinson Company
PCR is a registered trademark of Perkin Elmer Corporation

4.3 Derating Tables

Dense Samples

The Speed and Force Tables list the maximum speed for each rotor/adapter combination for the Multi Series. These speeds are specified for samples whose specific gravity is not greater than 1.2, for swinging bucket rotors, or 1.5, for fixed angle rotors.

For denser samples, the maximum specified speed is reduced (derated) by a factor from the table below:

Derating Factor for:

Derating Example: A rotor rated for 4,000 RPM, used with samples with a specific gravity of 1.4, cannot spin faster than 3,700 RPM. (4,000 x .925 = 3,700)

Specific Gravity	Swinging Bucket	Fixed Angle
1.2	1.000	1.000
1.3	.960	1.000
1.4	.925	1.000
1.5	.894	1.000
1.6	.866	.967
1.7	.839	.939
1.8	.816	.912
1.9	.794	.888
2.0	.774	.866
2.1	.755	.844
2.2	.738	.825
2.3	.721	.807
2.4	.707	.790
2.5	.692	.774
2.6	.678	.758
2.7	.666	.744
2.8	.654	.731
2.9	.642	.719
3.0	.632	.707

Specific gravities greater than 3.0. This table is based on the formula: $\sqrt{(S_o/S_a)}$

You can use the same formula to compute derating factors for specific gravities greater than 3.0.

- S_o is the maximum specific gravity allowed before derating (1.2).
- S_a is the actual specific gravity of the sample.

Caution: Do not exceed the rated speed or specific gravity. Higher speeds or specific gravities will impose unnecessary wear on the centrifuge, and can cause **rotor failure. Wear and damage caused in this manner are not covered under warranty.**

Microplate Sample Weight

The Microplate rotor is designed for centrifugation of multi-well microplates. The weight of the loaded microplates must be equally distributed between the rotor's two carriers. The maximum rated speed for the rotor, when each of the carriers is loaded with 1000 grams (total load of 2000 grams), is 4400 rpm.

Caution: Loads greater than 1000 grams (weight of the microplate and sample) must have maximum speed derated (according to the following table), to avoid **rotor failure.**

Derating Table for Microplate Rotor

Load per Carrier (grams)	Max. Speed (rpm)
1000	4400
1080	4350
1160	3100
1250	2950
1300	2700
Greater than 1350	do not use

4.4 Chemical Resistance Table

The Multi Series is made of materials that are designed to resist attack from most laboratory chemicals. A variety of materials, including aluminum and polypropylene, comprise the rotors and accessories. The Chemical Resistance table shows the suitability of each material, with different classes of reagents. **Note:** Chapter 5 describes how to clean and remove corrosion from the chamber, rotors, and accessories. Follow the instructions and clean spills promptly, to minimize the effect of corrosive chemicals and avoid expensive repairs.

	Plastic										Metal					Other			
	PA	PC	PE	PP	PU	NL	DN	CN	NN	PS	TI	SS	AL	MB	MG	RR	BN	VN	PF
Acids, dilute or weak	E	E	E	E	G	E	F	N	F	E	G	G	F	F	N	F	E	E	E
Acids*, strong or conc.	E	N	E	E	F	N	N	N	N	F	N	N	N	N	N	N	F	G	N
Alcohols, aliphatic	E	G	E	E	F	E	E	E	N	E	E	E	E	E	F	E	E	G	E
Aldehydes	G	F	G	G	G	G	G	G	F	N	E	E	E	E	E	E	N	E	E
Bases	E	N	E	E	N	G	N	G	F	E	E	E	E	E	E	G	G	N	N
Esters	G	N	G	G	N	E	G	G	E	N	E	E	E	E	E	N	N	N	E
Hydrocarbons, aliphatic	G	F	G	G	E	N	E	E	E	N	E	E	E	E	E	N	E	E	E
Hydrocarbons, aromatic	F	N	G	F	N	N	E	E	E	N	E	E	E	E	E	N	N	E	E
Hydrocarbons, halogenated	F	N	F	F	N	N	G	E	G	N	E	E	E	E	N	N	N	F	E
Ketones	G	N	G	G	N	N	E	E	E	N	E	G	G	G	E	N	N	N	E
Oxidizing Agents, strong	F	N	F	F	N	N	N	N	N	N	E	F	N	N	N	N	F	E	E
Salts	E	E	E	E	E	E	E	E	E	E	E	F	F	F	N	E	E	E	E

*For Oxidizing Acids, see "Oxidizing Agents, strong".

PA - POLYALLOMER
PC - POLYCARBONATE
PE - POLYETHYLENE
PP - POLYPROPYLENE
PU - POLYURETHANE
NL - MODIFIED PHENYLENE OXIDE (NORYL)
DN - ACETAL HOMOPOLYMER (DELRIN)
CN - ACETAL COPOLYMER (CELCON)
NN - NYLON
PS - POLYSTYRENE

TI - TITANIUM
SS - STAINLESS STEEL
AL - ALUMINUM
MB - MANGANESE BRONZE
MG - MAGNESIUM
RR - RUBBER
BN - BUNA-N
VN - VITON
PF - PHENOLIC FIBER

Classification of Resistance
E= Excellent
G= Good
F= Fair
N= Not Recommended

4.5 Decontamination Table

Compatible Processes For Decontamination

Sterilization Methods	Plastic										Metal					Other				
	PA	PC	PE	PP	PU	NL	DN	CN	NN	PS	TI	SS	AL	MB	MG	RR	BN	VN	PF	PT
Mechanical																				
Autoclave*	S	M	U	S	M	U	S	S	S	U	S	S	S	S	S	S	S	M	S	M
Ethylene Oxide Gas	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	U	U	S	S	S
Dry Heat (2Hrs. @ 160°C)	U	U	U	U	U	U	U	U	U	U	S	S	U	S	S	U	U	U	U	U
Chemical																				
Ethanol	S	S	S	S	U	S	S	S	U	M	S	S	S	S	S	S	S	S	S	S
40% Formalin	S	S	S	S	U	S	S	S	S	U	S	S	S	S	S	S	U	S	S	S
Methanol	S	M	S	S	M	S	S	S	U	M	S	S	S	S	S	S	S	U	S	S
Potassium Hydroxide	S	U	S	S	S	--	U	--	--	--	U	S	U	--	--	--	M	M	--	S
2-Propanol	S	S	S	S	M	S	S	S	U	S	S	S	S	S	M	S	S	S	S	S
.5% Sodium Hypochlorite**	S	S	S	S	U	S	U	U	U	S	S	M	U	U	U	S	U	S	S	M
3% Hydrogen Peroxide	S	S	S	S	S	S	M	S	U	S	S	S	S	S	U	S	S	S	S	M
100% Hydrogen Peroxide	S	S	S	S	S	U	U	U	U	S	S	S	S	S	S	U	U	S	S	U
5% Phenol Solution	M	U	U	S	U	U	M	M	U	M	M	M	M	M	M	M	U	S	S	U

*For Oxidizing Acids, see "Oxidizing Agents, strong".

PA - POLYALLOMER
PC - POLYCARBONATE
PE - POLYETHYLENE
PP - POLYPROPYLENE
PU - POLYURETHANE
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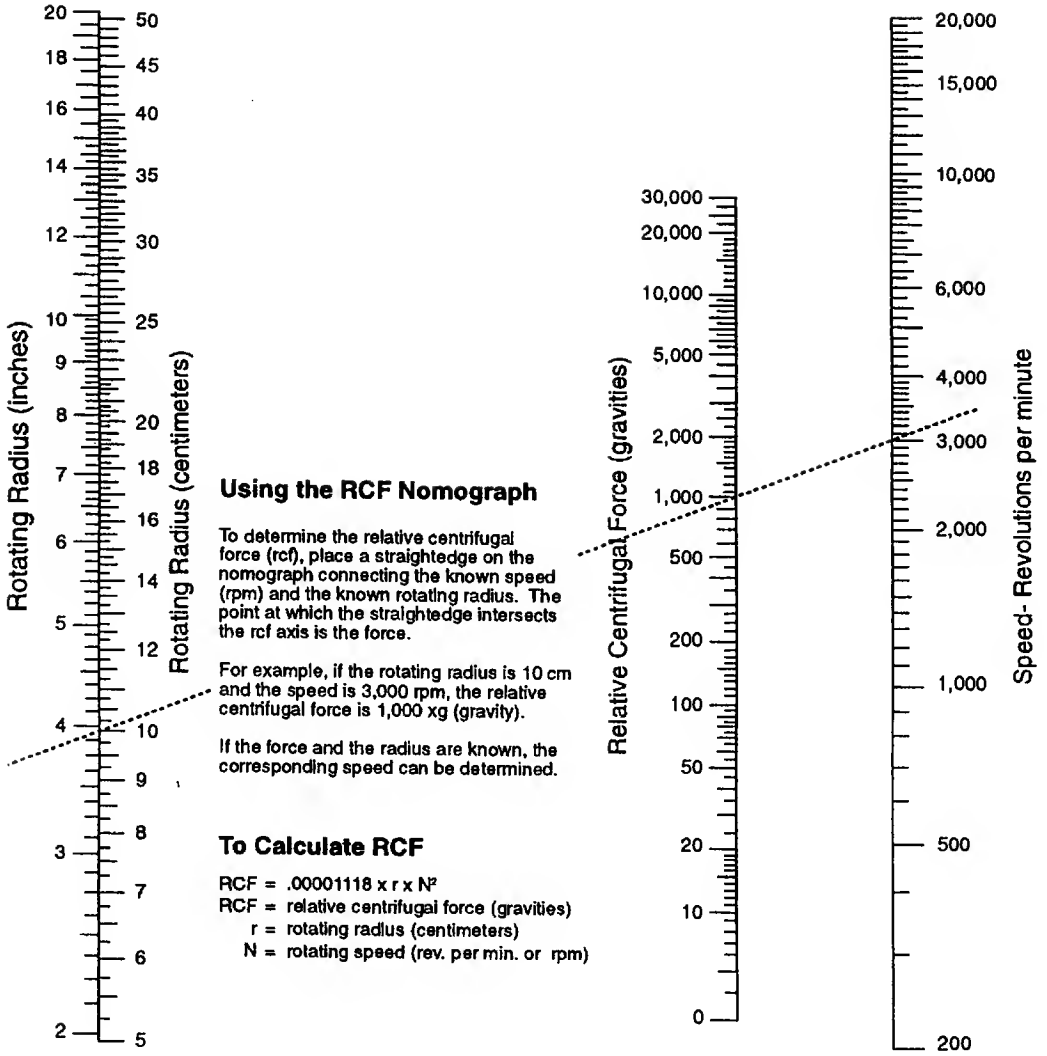
TI - TITANIUM
SS - STAINLESS STEEL
AL - ALUMINUM
MB - MANGANESE BRONZE
MG - MAGNESIUM
RR - RUBBER
BN - BUNA-N
VN - VITON
PF - PHENOLIC FIBER
PT - PAINTED SURFACES

*Autoclaving
121°C for 20 min.
@ 2 ATM (15 PSIG)
**1 to 10 Dilution of
Household Bleach

S=SATISFACTORY
M=MARGINAL
U=UNSATISFACTORY
-- = NO INFORMATION

Warning: This chart describes the material compatibility of various sterilization methods. It does not specify the adequacy of sterilization. Refer to section 4.4 - **Chemical Resistance Table**, for material compatibility during centrifugation.

4.6 RCF Nomograph



Using the RCF Nomograph

To determine the relative centrifugal force (rcf), place a straightedge on the nomograph connecting the known speed (rpm) and the known rotating radius. The point at which the straightedge intersects the rcf axis is the force.

For example, if the rotating radius is 10 cm and the speed is 3,000 rpm, the relative centrifugal force is 1,000 xg (gravity).

If the force and the radius are known, the corresponding speed can be determined.

To Calculate RCF

$RCF = .00001118 \times r \times N^2$

RCF = relative centrifugal force (gravities)
r = rotating radius (centimeters)
N = rotating speed (rev. per min. or rpm)

5 Maintenance

5.1 Introduction

This chapter explains how to keep your unit in good operating order. It includes instructions for cleaning, decontaminating, and storing. This chapter, also, covers the cover interlock bypass.

See the end of the chapter, for information on service and warrantees.

5.2 Care and Cleaning

Keep your centrifuge clean, to ensure good operation, and to extend its life.

Clean the sample chamber, rotor, and lid, at the end of each workday, and immediately after any spill. To clean the chamber, use a damp sponge, warm water, and a mild liquid detergent, suitable for washing dishes by hand, such as Ivory® liquid. Do not use caustic detergents, or detergents that contain chlorine ions. These attack metals.

Remove stubborn stains with a plastic scrub pad. Do not use steel wool, wire brushes, abrasives, or sandpaper. They create corrosion sites. Never pour water directly into the rotor chamber or near the motor shaft.

Scrub the rotor's tube cavities with a stiff test tube brush that has end bristles and a non-metallic tip. Dry each part, after cleaning, with a clean, absorbent towel.

If glass breakage occurs, remove all broken pieces immediately. If breakage recurs, replace all adapters and cushions. Particles of broken glass become embedded in the plastic or rubber accessories. Glass particles can come in contact with new glass tubes, creating pressure points that may result in breakage recurring. Glass particles, in the chamber, grind to a fine gray dust, during centrifugation. This dust can coat the inside of the centrifuge.

Corrosion

The manufacturer finishes the rotors and structural accessories to give maximum resistance to corrosion. To maximize the life of the unit, continually inspect the rotor cavities for corrosion, especially if you use chloride ion solutions, such as sodium chloride (saline), and sodium hypochlorite (household bleach), because these solutions attack most metals. Clean the rotor, rotor chamber, and accessories (particularly the sample compartments and bucket cups) thoroughly, after each exposure. Inspect all surfaces, under bright light, for corrosion. Be aware that small crevices grow deeper, eventually resulting in system failure.

If you see any corrosion, remove it immediately, using the following procedure:

1. Follow the cleaning procedure, at the start of this section.
2. Soak the product in mild hand dishwashing detergent, and scrub the product thoroughly with a stiff test tube brush. The brush should have end bristles and a non-metallic tip.
3. Soak the product, again, in clear warm water, for a minimum of an hour.
4. Rinse the product in warm water, then in distilled water.
5. Dry the product, thoroughly, with a clean, absorbent cloth.

Caution: If this procedure does not remove the corrosion, discontinue use of the product.

Storage

Store parts on a soft surface, to avoid damage. Rotors and other parts should be clean and dry. Store them open to the air, not in a plastic bag, so that any residual

moisture evaporates. Face the parts upward, to avoid moisture retention in the cavities.

Decontamination

If tube breakage occurs, releasing toxic, infectious, pathogenic, or radioactive material into the unit, decontaminate the chamber.

Rotors have sealed containers that provide aerosol containment and, if used as directed, keep spillage confined. If breakage occurs, it may be sufficient to only decontaminate the sealed carriers.

The Decontamination Table, in Chapter 4, lists the sensitivity of various materials to common sterilization procedures. When using a 1-to-10 dilution of household bleach (sodium hypochlorite), to decontaminate metal rotors or accessories, follow decontamination by the corrosion cleaning procedure (See 5.2), since chloride ions attack most metals.

Always decontaminate for the minimum recommended time. If you observe corrosion, remove it, as described earlier; discontinue use of the method; and use an alternate decontamination procedure.

Polypropylene sealed carriers can be autoclaved. Remove any sample tubes, before autoclaving, unless they are completely full of sample. Remove caps, stoppers, and other tube closures, before autoclaving, to keep the tubes from collapsing under pressure. Autoclave the rotor and accessories at 121 ° C @ 15 psig for 20 minutes. Do not stack polypropylene rotors during this process. After cooling, perform a normal cleaning operation, as described above.

Repeated autoclaving seriously degrades the performance of polycarbonate sealing covers.

5.3 Cover Interlock Bypass

The cover will remain locked, if power fails. If you need to remove samples from the unit, before power is restored, use the cover interlock bypass, after the rotor has come to a stop.

To bypass the cover interlock:

1. Unplug the centrifuge.
2. Locate the hidden plastic plugs (2), underneath the front ledge of the cabinet.
3. Use a screwdriver to pry out and remove both plugs.
4. Pull the attached cords simultaneously, to release the cover interlock.
5. Replace the plugs in the holes.

Do not perform this operation routinely. The centrifuge's cover interlock provides operator safety. It allows the cover to be opened promptly, whenever rotation has stopped.

5.4 Fuses not replaceable by operator

The following fuses are located internally within the centrifuge. Only qualified service personnel should replace these fuses.

Power Supply PCB

F1	1.6A - Slow Blow, 250V
F2	1.6A - Slow Blow, 250V
F3	10A - Slow Blow, 250V

Power Amplifier PCB

F1	8A - Fast Blow, 250V

5.5 Condition of Returned Equipment

Contact IEC and obtain return goods authorization (RGA) number, before returning equipment to the manufacturer. The RGA paperwork includes a Certificate of Decontamination for you to sign. It indicates that you have performed the proper steps for decontaminating the unit.

Warning: All returned units must be decontaminated, free of radioactivity, and free of hazardous, infectious, pathogenic, or toxic materials.

All return equipment shipments will be refused until the signed certificate is received.

You must prepay transportation to the service depot.

5.6 Warranty

IEC wants you to be satisfied with the quality of your Multi Series centrifuge. We warranty the centrifuge for one year and rotors for seven years. We will repair or replace any of these products that fail, within this period, from the date of its delivery, due to defects in material and workmanship, and we will ship you the repaired product or its replacement at our expense. You must use IEC-approved rotors and accessories, and genuine IEC spare parts. This warranty does not apply to any instrument that has been abused or repaired without authorization.

THE FOREGOING OBLIGATIONS ARE IN LIEU OF ALL OTHER OBLIGATIONS AND LIABILITIES INCLUDING NEGLIGENCE, AND ALL WARRANTIES, OF MERCHANTABILITY OR OTHERWISE, EXPRESSED OR IMPLIED IN FACT OR BYLAW. THE FOREGOING STATES OUR ENTIRE AND EXCLUSIVE LIABILITY, AND BUYER'S EXCLUSIVE REMEDY, FOR ANY CLAIM OR DAMAGES IN CONNECTION WITH THE SALE OR FURNISHING OF GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION, OR OPERATION. IEC WILL IN NO EVENT BE LIABLE FOR ANY SPECIAL OR CONSEQUENTIAL DAMAGES WHATSOEVER AND OUR LIABILITY UNDER NO CIRCUMSTANCES WILL EXCEED THE PURCHASE PRICE FOR THE GOODS FOR WHICH LIABILITY IS CLAIMED.

6 Specifications

Maximum Speed:	16,800 RPM

Maximum G Force:	30,600 xg
Maximum Rotating Radius:	17.5 cm
Maximum Capacity:	1 liter (4 x 250 ml)
Sound Level:	
Multi	not to exceed 70 dbA (RMS)
Multi RF	not to exceed 65 dbA (RMS) w/ compressor on

Operator Controls

Chamber Temperature: Multi RF only	-9° to 40° C by 1°
Rotation:	Counterclockwise
RPM:	500-16,800 (by 50 RPM)
RCF:	50-30,600xg (by 50 xg)
Spin Duration:	0-99 hours, 59 min, 59 sec by 1 hour, 1 min and/or 1 sec At Start Timer At Speed Timer Hold Mode Centrifugal Integrator ($\int\omega^2 dt$) Pulse (Momentary Spin)
Brake:	Active Electric 3 preset profiles 1 settable profiles

Repeatability

Temperature Control: Multi RF only	± 2° C within range of 4° C to ambient
Rotation:	Accuracy within ±20 RPM
Timer:	Microprocessor controlled Accuracy within ± 1 sec

System Components

Motor:	1 hp, Brushless DC
Refrigeration System: Multi RF only	1/2 hp nominal
Refrigerant: Multi RF only	non-CFC R-404A (11.5 oz 60 Hz Models) R-404A (12.3 oz 50 Hz Models)
Operating pressures: at 4°_C (Multi RF only)	15 psi (low side) 210 psi (high side, 60 Hz Models) 250 psi (high side, 50 Hz Models)
Max sample temperature rise: Multi only	7°C above ambient* *except for 8685 & 8850 rotors

Power Requirements and Output

s/n	Description	Electrical Requirements
8464...	Multi Ventilated	120 VAC, 60 Hz
8465...	Multi Ventilated	220 - 240 VAC, 50/60 Hz
8466...	Multi RF Refrigerated	120 VAC, 60 Hz
8467...	Multi RF Refrigerated	220 - 240 VAC, 50 Hz
8468...	Multi RF Refrigerated	220 - 230 VAC, 60 Hz

Current:	Model 8464	7 Amps
	Model 8465	6 Amps

	Model 8466	12 Amps
	Model 8467 & 8468	8 Amps
Heat Output:		
Multi		2700 Btu/hr
Multi RF	(Comp Off)	2640 Btu/hr
Multi RF	(Comp On)	4200 Btu/hr
Dimensions		
Height:	Multi and Multi RF	16.3" (41.3 cm)
Width:	Multi	20.6" (52.4 cm)
	Multi RF	30.8" (78.1 cm)
Depth:	Multi and Multi RF	25.8" (65.4 cm)

Shipping Dimensions:		
	Multi	Multi RF
Height	24 in (60.9 cm)	22 in (55.9 cm)
Width	34.4 in (87.3 cm)	34.8 in (88.3 cm)
Depth	27.8 in (70.5 cm)	30.8 in (78.1 cm)

Unit Weight:	
Multi	173 lb. (79 kg)
Multi RF	254 lb. (116 kg)
Shipping Weight:	
Multi	220 lb. (100 kg)
Multi RF	304 lb. (138 kg)

Specifications Subject To Change Without Notice

7 Service

7.1 Warnings and Cautions

Warnings

The following hazards exist in servicing the Multi Series:

The units use AC power. Some of the service procedures require operation with the cabinet or control panel off, exposing power lines. This introduces the risk of electrical shocks. Do not touch exposed wires without first unplugging the unit.

Some components on the circuit board operate at high voltage. Do not touch board components when the power cord is plugged in.

The Multi (RF) use pressurized refrigerant gases that are potential asphyxiants. All maintenance on the refrigeration unit should be performed in a well-ventilated area. If it becomes necessary to discharge or recharge the refrigeration system, only specially trained personnel with proper recovery systems should perform this operation.

The power cord(s) provided with these units are correctly rated for the highest current demand. Do not exchange the supplied cord with cords from other equipment. Exchange of power cords between equipment may create a fire hazard.

Cautions

An additional hazard to the equipment is as follows:

The circuit board contains electronics that can be damaged by static electricity. Persons doing extensive maintenance on the circuit board, or removing individual components from the circuit board, should be grounded (such as by wearing a wrist strap). When shipping a circuit board, always enclose it in a static-protective bag.

7.2 Special Tools

No special tools are required. A multimeter is required to perform diagnostics.

7.3 Troubleshooting

Use the following chart to help identify the source of service problems:

I. Motor won't start; display shows 'Err 1' error.

A. Unplug the power cord, then plug the power cord back in to clear error code.
B. Spin the rotor by hand and look at the speed display you should see the RPM's change verifying the tachometer function.
C. Check motor. See section xxx
D. Check speed sensor. See section xxx
E. Check brake resistor. See section xxx
F. Check power board. See section xxx

II. Cover wont open when stop/open key is pressed.

A. Check cover solenoid resistance. See section xxx
B. Remove front control panel and check latch/solenoid linkage for binding.
C. Check PC Board for power to solenoid. See section xx

III. Cover won't stay upright when opened.

A. Check the gas spring of the cover. See section xxx

IV. 'Bal' is displayed on control panel, or unit vibrates when running. Open cover to remove error message.

A. Try running unit with only the rotor (no accessories). If vibration stops check buckets for matched weights to within 1 gram (including adapters and cushions).
B. Check that samples and accessories are balanced inside chamber (use scale to verify) not only across the rotor, but also about the pivot axis of each bucket. See section 3.1 Rotor and Accessories
C. Check buckets for fit and pivot ability (swing action). Contact IEC and discontinue using unit if buckets seem tight on the rotor pivot pins.
D. Clean rotor-bucket pivot points and lubricate with IEC lubricant part # 07133.
E. Check that centrifuge is placed on a level, vibration free surface (work bench).
F. Check motor mounts for wear or play.
G. Check motor shaft for any sign of bending (T.I.R. < 0.002").

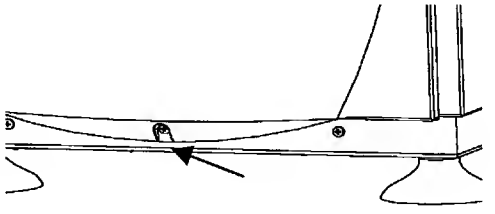
H. Check for operation at observed critical speeds (between 1800-2200 rpm), and adjust speed if possible.
I. Replace Imbalance pc board.

V. **Unit does not seem to brake.**
A. Check that one of the brake profiles is selected.
B. Ohm out the brake resistor @ J2 on the Power amp pc board. The 2 yellow wires go to the resistor they should be 750K ohms.

8 Cabinet

7.4 Control Panel Removal

Removal of the control panel allows access to many internal components. Follow this procedure to remove the control panel:



1. Open the cover.
2. Unplug the centrifuge.
3. Remove 1 Phillips screw from the bottom center edge of the control panel. (See illistration).
4. Gently pull the bottom of the panel outward and slide panel downward to disengage the clips holding it into place.
5. Place the panel down, in front of the unit, taking care not to damage any of the wire harnesses.
6. For full removal of the control panel, disconnect all wiring harnesses from the Logic/Display PCB.

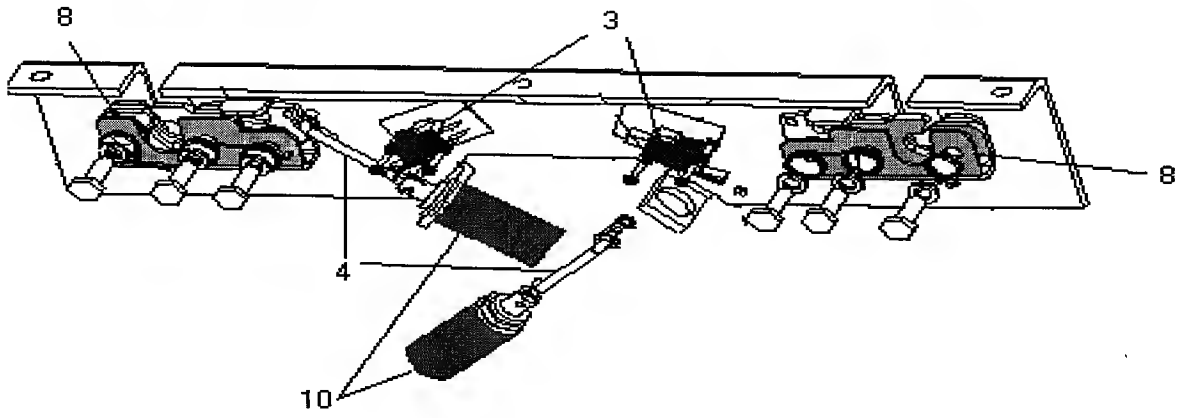
7.5 Cabinet Housing Removal

1. Unplug the centrifuge.
2. Completely remove the front control panel. See section XXX
3. Disconnect all wiring harnesses that connect to components attached to the houseing.
4. Remove the grill at the rear of the centrifuge, by removing 4 Phillips screws. (On ventilated units, the removal of the rear grill will give access to the motor fan.)
5. Pry off the bottom gas spring anchor cap and remove the c-clip fastened on the gas spring.
   Note: Because of the weight of the cover, cover should be closed.
6. Pop off the bottom gas spring from the bracket that is attached at the end.
7. Remove the 8-12 Phillips screws around the underside of the cabinet housing.
8. Lift off the cabinet housing, the cover, and the latch assembly as a unit. (Removing the assembly may be easier with the cover closed.)

Note: The bottom gas spring should be removed before lifting the cabinet assembly.

7.6 Latch Assembly

The latch assembly consists of two latches **#8**, two microswitches **#3**, two linkages **#4**, and two solenoids with plungers **#10**. When the cover is closed, the two cover strikers engage the latches into the locked and closed position; the solenoid plungers make the two microswitches. The microswitches sense the status of the cover (open, closed/locked). This then signals the Logic/Display PCB that microswitches are made and the lid is closed. The solenoids release the latch when activated.



Latch Assembly Replacement
To remove/replace the latch assembly (which includes the latches, switches, solenoids, and linkages):

1. Unplug the centrifuge.
2. Remove the front control panel.
3. Disconnect the J1 connector for the cover switch from the Logic/Display PCB.
4. Disconnect the J7 connector for the solenoid coils from the Power Factor Correction PCB.
5. Remove the two plastic plugs from the two bypass cords.
6. Remove the nuts that secure the latch assemblies to the cabinet (quantity 2 for each latch, 5/16").
7. Reassemble with the new latch assembly.

Individual latches may require replacement, if it is difficult to engage the striker. Try to adjust the strikers on the lid, prior to replacement. The cover strikers should engage the latches as easily as activating the latch by hand. A properly adjusted cover will engage the switches when closed and not leave an air gap, (critical on refrigerated units), between the cover and the gasket.

To replace the latch:

1. Remove the front control panel.
2. Disconnect all connector to the latch assembly.
3. Loosen the retaining nut that secures the solenoid.
4. Slide the solenoid out.
5. Remove the two link arms and bypass cords from the latches.
6. Remove the 3 ½" bolts that secure the latch to the bracket.
7. Reassemble the new latch.

To test the microswitches
The Multi/R has two interlocks and two microswitches. The two microswitches are wired in series. The two switches can be tested using the following procedure:

1. Remove the front control panel.

2. Disconnect the J1 connector for the cover switchs from the Logic/Display PCB.
3. Use a multimeter to measure the resistance of the microswitchs, in series.

    - The switches should read open, when the cover is open.
    - The switches should read closed, when the cover is closed.

4. If the reading are not as expected, verify by measuring each switch directly.
5. The switches may be adjusted slightly by loosening the mounting screws, holding them in place, and re-tightening the screws. The actuator arm of the switch may also be adjusted (bent) to improve performance.

To replace the microswitches

1. Remove the control panel.
2. Note the wiring to the switch and disconnect it.
3. Remove the two (2) small screws that secure the switch in place.
4. Reposition the new switch so that the actuator arm is located above the roll pin of the solenoid plunger. Align it so that the conditions mentioned above ("To test the microswitches") are met.
5. Secure it with the screws. Refer to wiring diagrams.

Solenoid

The solenoids release the latches, when the cover open button is pressed and the rotor speed is at a safe, low speed (less than 100rpm).

To test the solenoids

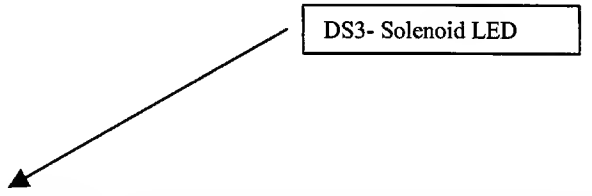
Resistance of the solenoid coil should measure approximately **77Ω**. This can be measured with the unit unplugged and the front panel removed, across the two white leads at J7 on the Power Factor Correction PCB.

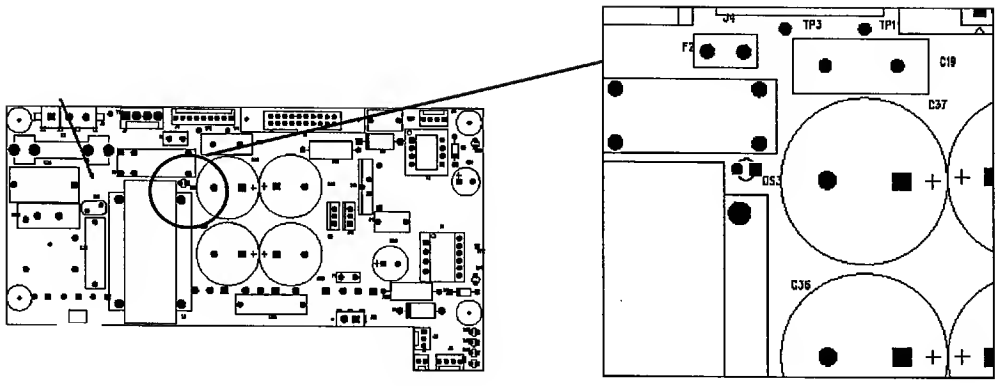
To check if DC voltage is being delivered to the solenoids,

1. Remove the front control panel.
2. Remove the connector J7 at the Power Factor Correction PCB and prepare to measure the voltage output across the two PCB pins of that connector. The voltage output is for a fraction of a second, so a multimeter with a peak hold function is required. The expected value is approximately **165Volts DC**.
3. Plug the centrifuge in, turn on the power switch, close the cover and press the STOP/LID cover button to activate the solenoid.
4. If voltage is found on Power Factor Correction PCB, but the solenoid does not activate the latch, check the linkage for binding, before replacing the solenoid.
5. If no voltage is present, then replace the Power Factor Correction PCB.

Solenoid LED

Voltage to the solenoid can also be tested through the LED on the Power Factor Correction PCB. The green LED (DS3), located near the choke (red wired) and the diode, lights up when the STOP/LID is pressed. (The green LED can be seen through the reflection on the capacitor, shown below).



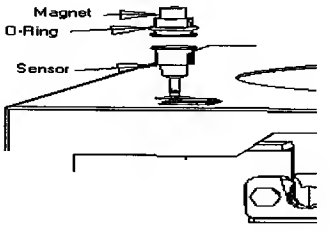


Solenoid Replacement

1. Remove the front control panel.
2. Disconnect the wiring to the solenoid.
3. Loosen the retaining nut.
4. Slide the solenoid out.
5. Slide the new solenoid into place.
6. Secure the retaining nut.
7. Reattach the wiring harness.

Proximity Switch

The proximity switch senses the position of the cover for the purpose of disabling the run unless the cover is fully closed. The proximity switch consists of a magnet and a switch, located in the cover and actuates the switch located in the cabinet when the cover is closed. The proximity switch is in line with the motor control system and signals the Motor Drive PCB to "run".



To test the proximity switch

1. Disconnect the two white leads, which go to the proximity switch located in the top (left front) of the cabinet.
2. Use a multimeter to measure the resistance across the leads.
   - The switch should read open, when the cover is open.
   - The switch should read closed, when the cover is closed.
3. If the readings are not as expected the proximity switch may be defective and need to be replaced. Prior to replacement, check the magnet in the cover for strength, and ensure that the magnet comes in close proximity with the switch (sensor portion located in the cabinet) when the cover is closed. The cover may need adjusting to position the magnet closer to the switch. Both the switch and magnet may be shimmed to meet more closely.

To replace the proximity switch

1. Remove the control panel.
2. Note the wiring to the switch and disconnect it.
3. Remove the retaining clip.
4. Push the switch (located in the cabinet) up and out.
5. Install the new switch and retaining clip.
6. Connect the wiring harness according to the wiring diagram.
7. Using a small flathead screwdriver, pry out the magnet portion located in the cover. Remove and reinstall the o-ring spacer.

7.7 Cover Assembly

The cover assembly is secured to the cabinet housing by a hinge and one gas spring. The cover engages a gasket to keep the chamber sealed. This gasket keeps the refrigerated models from developing too much frost, and allows them to achieve maximum cooling efficiency and performance. This gasket is held in place by a friction fit. If it becomes loose or deteriorates over time, it should be replaced.

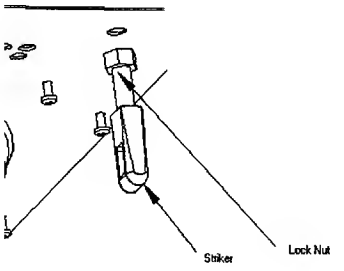
Non-refrigerated units have an air baffle inside of the cover. This baffle contains a path for proper air circulation. If this path becomes blocked, the chamber and samples may overheat. Proper airflow can be verified by placing your hand over the vent holes along the back, right, of the cover assembly. Airflow should be evident through these vents, but not along the sides of the cover.

Cover Adjustments

Using a long strip of paper 1 –2 inches wide drapped across the gasket close the cover. You should feel tension when the strip is pulled from the centrifuge. If the strip binds the cover is too tight, if the strip has no tension the cover is too loose. It is critical that adjustments are made if either of these conditions exists. If the cover does not close easily, or if it must be pushed down to enable the unit to run, the latch switch or assembly may be loose, or the cover latch strikers (2) may need adjustment.

To adjust either of the two cover latch strikers:

1. Loosen the locking nut that holds it in place.
2. Adjust the striker by screwing it up or down, to correct its height for locking.
3. Be sure to lock it back into place by tightening the locking nut with a wrench. This will prevent it from loosening when the unit is in operation.

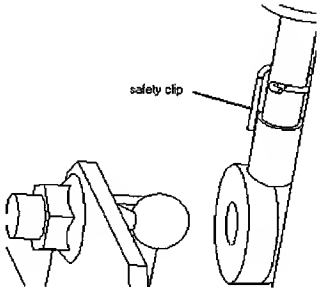


A properly adjusted cover will result in no Lid warning and no air leakage around the sides and front of the cover. Airflow from the rear of a ventilated unit is normal.

Gas Springs (2) Replacement

If the cover assembly does not stay open on its own, one or both of the cover gas struts may need to be Replaced. With the gas strut disconnected from the cover at the top try to force the strut down, if you can Move it with your hand the strut is defective.

1. Unplug the centrifuge.
2. Pry off the gas strut anchor cap at the top of the strut. Pry the gas strut from the bracket.
3. Remove the grill at the rear of the centrifuge, by removing 4 Phillips screws. (On ventilated units, the removal of the rear grill will give access to the motor fan.)
4. Pry off the bottom gas strut anchor cap and remove the c-clip fastened on the gas spring.
5. Pry off the bottom of the gas strut from the bracket that it's attached to.



Note: The black portion of the gas spring should be visible when the lid is opened.

7.8 Guard Bowl

The cover and guard bowl forms the centrifuge chamber. The guard bowl is anodized and Teflon coated.

Replacement
Use the following procedure to remove the guard bowl:

On Multi ventilated units:

1. Remove the cabinet.
2. Remove the rotor recognition hood and motor boot by removing the four (4) Phillips head screws, which secure it. Then, the rotor recognition and boot assembly can be pulled away from the guard bowl for removal.
3. Remove the 4 mounting screws that hold guard bowl, to free it from the support legs.

Note: For re-assembly, a bead of vacuum grease should be applied to the groove of the motor boot, where it attaches to the guard bowl.

On Multi refrigerated units:
On refrigerated units the guard bowl is part of the evaporator foam assembly. It cannot be removed without breaking into the refrigeration system. ***Only specially trained personnel with proper recovery systems should perform service on the refrigeration system.***

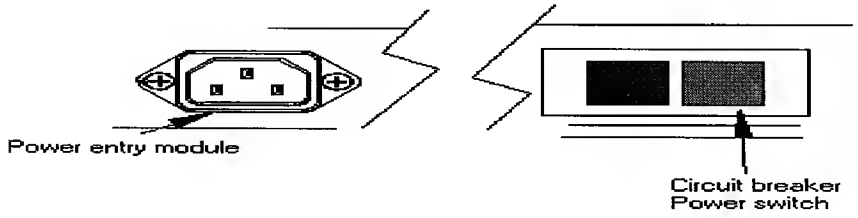
The evaporator foam assembly can be raised slightly, to aid in replacement of the components mounted on the baseplate of the centrifuge. Use this procedure to raise the foam assembly:

1. Remove the cabinet.
2. Disconnect the rotor recognition harness at J3 of the Logic/Display PCB.
3. Remove the 4 mounting bolts that hold the evaporator foam assembly to the support legs. The evaporator foam assembly can be slightly raised.
4. Use a screwdriver as a wedge, or place blocks under the edges of the steel ring, to hold the assembly up. This will bend the refrigeration tubing, so take care to avoid damage to the refrigeration system.

8 POWER CIRCUIT

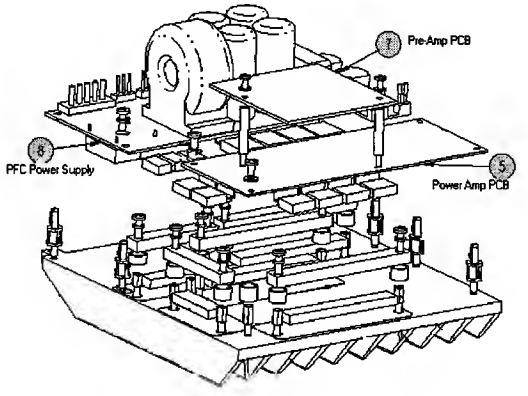
8.1 GENERAL

The Power Entry Module is where power is supplied to the centrifuge, via the power cord. A Power switch / circuit breaker is located to the right of the power entry module. **Power configuration is described in Section 2.3.**



Power Test
Use the following procedure to verify power to the PC boards.

WARNING: This procedure requires operation of the unit with power applied and the front panel removed. Use caution to avoid electric shock.
See Section 7.1, Warnings and Cautions.



1. Remove the front control panel (see Section 8.1).
2. With power applied to the unit, measure the input voltage (120 VAC) on the PFC Power Supply PCB @ J9 pins 1 & 3.
3. Across TP3 (GND) and TP1 (15VDC). Voltage should be approximately 15 volts DC.
4. Across TP3 (GND) and TP2 (5VDC). Voltage should be approximately 5 volts DC.

If input voltage is not present, use the wiring diagram to trace back through the line filter, circuit breaker/power switch, and power entry module, to locate any failed components.
If either the 5 VDC or 15 VDC is not present the failed component is on the PFC Power Supply PCB.

For further troubleshooting of a suspected PCB problem, see Chapter 10, Printed Circuit Boards.

8.2 Power Switch/Circuit Breaker

All models have either a 10 or 15 AMP Power Switch /Circuit Breaker. (See the wiring diagram for your model to confirm which breaker.) It is located on the lower left side of each unit, near the line cord. Once tripped, (green plunger out), the circuit breaker stops power from being applied to the rest of the unit. Pushing in the green plunger in resets the circuit breaker.

Test
If the Power Switch/Circuit Breaker continues to trip, follow this troubleshooting procedure:

WARNING: This procedure requires operation of the unit with power applied and the front panel removed. Use caution to avoid electric shock. See Section 7.1, Warnings and Cautions.

1. Remove the front control panel (see Section 8.1).
2. Disconnect all connections to the Power Supply PC board.
3. Apply power.

If the Power Switch/Circuit Breaker trips search for a short in the power switch/circuit breaker, the power entry module, or the line filter.

4. If the breaker has not tripped, remove power, and connect J1 to the Power Supply PC board and power the unit back on. If the breaker trips, replace the Power Supply PCB.
5. If the breaker does not trip, repeat step 4 for all the other connectors, one-by-one. Once the breaker trips, search for a short in the last component that was connected.

Replacement

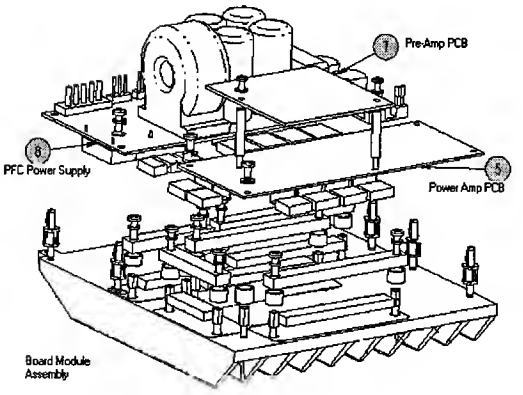
To remove the Power Switch/Circuit Breaker:

1. Remove the front control panel (see Section 8.1).
2. Remove the cabinet (see Section 8.2).
3. Depress the tabs on each side that hold the Power Switch/Circuit Breaker in place.
4. Slide the Power Switch/Circuit Breaker out.
5. Disconnect the leads.
6. Install the new circuit breaker in the same manner.

9 POWER CIRCUIT

Printed Circuit Board

The Multi incorporates two main PCB assemblies: Board Module Assembly, (Power Factor Correction PCB, Power Amp PCB and the Pre-Amp PCB), and the Logic/Display PCB.



The Power Factor Correction PCB (PFC)

The Power Factor Correction PCB produces high voltage (300VDC) to drive the motor and to power the Pre-Amp PCB. The Power Factor Correction PCB also produces low voltage to power the Logic/Display PCB. The power supplied to the Logic/Display PCB is isolated through a separate transformer on the Power Factor Correction PCB.

The Logic/Display PCB

The microcontroller (Display / Logic) circuit board consists of the controlling microprocessor (68HC11 microcontroller) and associated memory, logic and display. The board controls all machine functions based on inputs from the user interface, lid position sensors, refrigeration temperature sensor, imbalance sensor, rotor recognition system, and the motor Drive Board Assembly. The Multi microcontroller is an embedded system design. The non-volatile RAM in an extended memory map allows the recall of programmed parameters, even after power line interruption. The membrane keyboard and user interface displays are integral to the embedded system design and under full microprocessor supervision.

On the Logic/Display circuit board, U13 is a 68HC11 microcontroller. It is an eight-bit machine with synchronous ports for data and address busses. It also has synchronous and asynchronous serial ports, an eight bit general purpose I/O port, and a four input eight-bit analog to digital converter.

The system control software is U10, a 27C256 EPROM. U12 is the nonvolatile RAM. U8 is the under voltage sensing device which triggers a PFAIL error when the +5 VDC Logic voltage dips too low.

The Drive Board Assembly

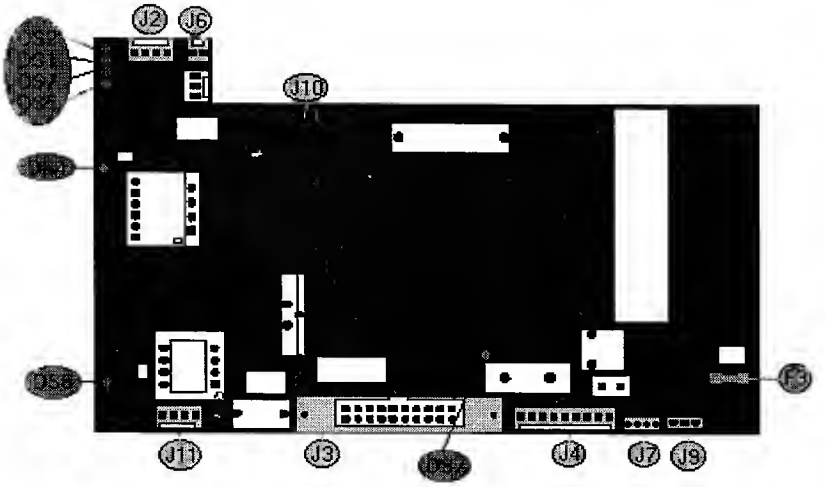
The drive motor is a brushless DC motor. Power is applied to the motor by the 3-phase sequencing of 6 MOSFET transistors. Only one pair of the MOSFETS is on at any given time. The Drive Board Assembly powers and brakes the three-phase DC brushless motor based on PWM and control inputs from the Logic/Display board and tachometry inputs from the motor. The assembly consists of a Pre Amp board, Power Amp board, and heat sink. The Pre Amp board contains the logic and motor controller circuits. The microprocessor monitors a thermal protection device, RT1, on the board. If the drive components reach a temperature in excess of 65 degrees centigrade, the unit will be shut down and an error code (COOL) will be displayed.

Fuse

The purpose of the fuses on the PC boards is to protect the components from catching on fire. Any blown fuse on the board indicates that there is a short to ground. There are two fuses on the Power Factor Correction PCB that protect the Solenoid Assembly and the latch mosfets. The red fuse is a 1.5 amp SLO-BLO fuse that protects the solenoid and the yellow fuse is also 1.5 amp SLO-BLO and is the low voltage fuse.

PCB LEDs

Power Factor Correction PCB



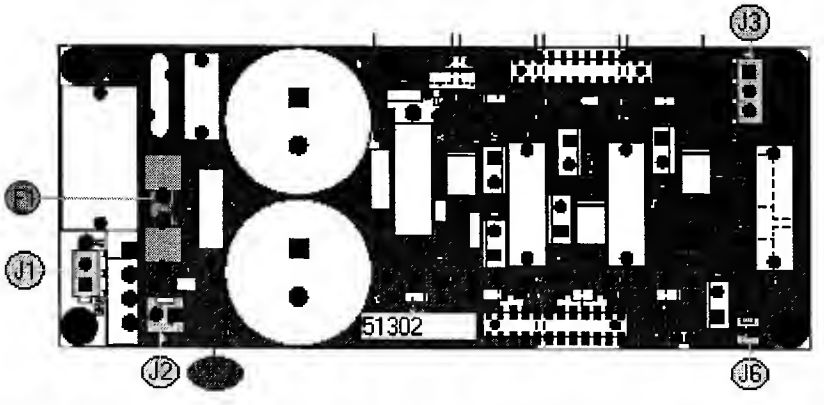
The Power Factor Correction PCB consists of 7 LEDs.

- **FAN (DS2)**- controls the fan. This green LED indicated that the motor blower (for ventilated units) or condenser fan (refrigerated units) is activated. These fans are activated whenever cooling is called for (for refrigerated models) or the motor drive circuit is active (on) for ventilated units. They continue to run for 60 seconds after the end of a run or after refrigeration shut off (refrigerated models only).
- **COMP (DS1)**- controls the compressor. This greed LED indicates that the compressor circuit is activated. AC power is provided through the activation of an AC drive circuit, comprised of U2 and a base mounted solid-state relay.
- **Hi-Volt (DS7)**- Hi-Volt (300V) on the Power Factor Correction PCB. *Note: Do not service the unit or any of the components inside the unit when this LED is on. Service this unit only when LED is OFF.*
- **+15VDC (DS5)**- indicates the 15VDC on the Power Supply PCB and the Drive Board Assembly. (Always ON when powered)
- **+5VDC (DS4)**- This LED indicates the +5VDC for the Logic/Display PCB. (Always ON when powered)
- **Logic Power Supply (DS6)**- indicates that Logic Power Supply is present. 8VDC would be measured on the Power Factor Correction PCB and 5VDC would be found on the Logic/Display PCB.
- **SOL (DS3)**- This green LED indicated when the cover solenoid drive circuit is activated. The solenoid retracts when energized to release the cover latch. AC power is provided through the activation of an AC drive circuit.
- **J9** is the 120 VAC supply for the PFC Power board.
- **J2** supplies the 5vdc power to the compressor SSR & the fan relay.
- **J7** supplies the 170vdc power to the 2-solenoild valves.
- **J10** supplies the 170 to 350 vdc to the Power Amp pcb.
- **J6** supplies 5vdc to the Power Amp pcb.

Driver Board Assembly

Power Amp PCB

- **DS1 (RED)**- indicates the high voltage (300VDC) is present from the Power Factor Correction PCB (J10) to the Power Amp PCB (J1) and to drive the

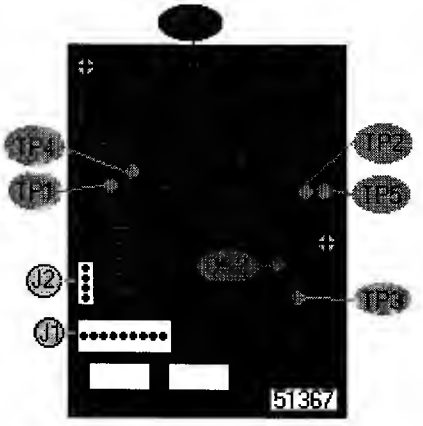


motor. *Note: Do not service the unit or any of the components inside the unit when this LED is on. Service this unit only when LED is OFF.*

- **J1** is the 300-**vdc** supply to the Power Amp pcb.
- **J2** connects the Power Amp pcb to the brake resistor. (should read 760k ohms).

Pre-Amp PCB

DS1- is the idle/fault LED. When the motor is idle, the LED would be lit. LED flashes during startup.
DS2- is the current sensor LED. The LED comes on when unit reaches a current limit or when the brake turns on.
DS3- is lit when unit is running. At this time, DS1 would be OFF.



Replacing the Circuit Boards

The Power Factor Correction PCB and the Driver Assembly PCB are all mounted on a barge. Removal of any of these PC boards would require removal of the barge.

To replace the Power Factor Correction PCB:

1. Remove the front control panel
2. Disconnect all connectors from the Power Factor Correction PCB and Driver Board Assembly.
3. Remove the barge, by removing the 2 Phillips screws, which secure the barge assembly to the base of the unit.
4. Remove the 2 clamp bars by removing the 5 Phillips screws.
5. Remove the center Phillips screw on the Power Factor Correction PCB.
6. The Power Factor Correction PCB is held in place by 4 standoff pins. To remove, squeeze the pins and pull the PCB up (pins can easily be squeezed using pliers).
7. Replace the Power Factor Correction PCB and re-install by reversing these steps.

To replace the Driver Board Assembly:

1. Remove the front control panel.
2. Disconnect all connectors from the Power Factor Correction PCB and Driver Board Assembly.
3. Remove the barge, by removing the 2 Phillips screws, which secure the barge assembly to the base of the unit.
4. Remove the clamp bar that secures the Driver Board Assembly by removing the Phillips screws.
5. The Driver Board Assembly is held in place by 4 standoff pins. To remove, squeeze the pins and pull the PCB up (pins can easily be squeezed using pliers).
6. Replace the Driver Board Assembly and re-install by reversing these steps.

To remove the Logic/Display PCB:

1. Remove the front control panel.
2. Disconnect all connectors from the Logic/Display PCB.
3. Remove the 6 Phillips head screws that secure the board in place.
4. Lift off the circuit board.
5. Replace and reassemble with the new Logic/Display PCB.
6. ***On initial power up (after replacement), press and hold the STOP key while powering the centrifuge on. Continue to hold in the STOP key until 7 beeps are heard. This is required to reset the microprocessor.***

Drive Assembly

The Multi Series drive assembly consists of a brushless DC motor with built in Hall effect speed sensors. The Pulse Width Modulation (PWM) of a 300 VDC power source controls the motor. The 300 VDC is rectified 230 VAC through BR1 on the Power Amp PCB. The 230 VAC is supplied by line voltage (on 220 – 240 volt models) or through a step up transformer (on 120 volt models).

The motor does consist of fan blades, which allows for better cooling of the motor and the components on the PC board in the unit.

Some electrical motor characteristics can be checked when the unit is unplugged. These procedures are outlined in this section.

Test

To measure the resistance of the motor, follow this procedure:

1. Remove the front control panel.
2. Remove the barge by removing the Phillips head screws.
3. Remove connector J3 from the Power Amp board
4. Measure the following resistances:

Between WHT, RED, BLU. ~ .6 Ω (any combination)

If any combination shows open, replace the motor. If they are correct, measure the resistance of all the leads to the ground terminal (chassis). All three should be open when measured to ground.

To verify power is being applied to the motor, follow this procedure:

1. Remove the front control panel.
2. Remove the barge, by removing the Phillips head screws.
3. Lift the barge halfway out to get to the J3 connector from the Driver Board Assembly.
4. Verify that the motor voltage is present. DS1, the red LED on the Power Amp PCB, should be ON when power is applied and motor voltage is present. If the voltage is not present, trace back through the power circuit (using the wiring diagram) to find where the 230VAC to the Power PCB is lost.
5. If the LED is ON, insert multimeter leads into the back of the shell connector of J3 at the Power Amp PCB to measure the DC voltage across the RED, WHT, or BLU leads in any combination.
6. Plug the unit in and verify that a rotor is properly installed.
7. Select an appropriate speed and time, select soft acceleration, and start a run.

Voltage should be present, but will fluctuate (a voltmeter with peak hold will confirm the presence of voltage). If no voltage is present, replace the Power Supply PC board.

Motor Replacement

Use the following procedure to replace the motor:

1. Open the cover.
2. Unplug the unit.
3. Remove the rotor and all accessories.
4. Disconnect all connectors from the motor.
5. Remove the rotor recognition hood and motor boot by removing the four (4) Phillips head screws, which secure it. Then, the rotor recognition and boot assembly can be pulled away from the guard bowl for removal.
6. Remove the front control panel.
7. From the Driver Board Assembly, disconnect J3 on the Power Amp board, and J2 on the Pre-Amp board.
8. Remove the 6 bolts that secure the motor.
   (A 10" extension, with a 5/16" magnetic socket will make this easier. Be careful not to drop the bolts.)

9. Disconnect the ground wire to the motor.
10. Lift the motor out.
11. Replace the motor in the same fashion, reversing the steps.

Note: ***For re-assembly on refrigerated units, it is recommended that a bead of vacuum grease be applied to the groove of the motor boot, where it attaches to the guard bowl. This allows for a better seal. It is also recommended that a bead of RTV be applied around the neoprene hood (the shaft seal) for extra protection against condensation.***

Speed Sensor

The speed sensor is comprised of three Hall effect sensors, which sense pulses from the armature magnet. It does not require calibration or adjustment. Its accuracy (+/- 10 rpm) can be verified by strobing the motor shaft through the viewport in the cover.

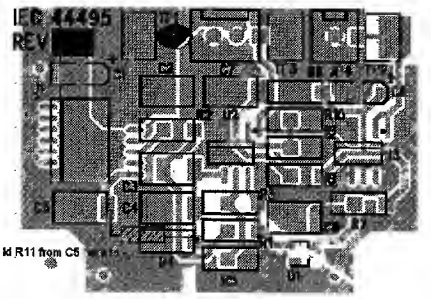
Test

Power to the speed sensor (5 VDC) can be verified across pins 1 & 5 (GRY & YEL) of J2 of the Pre Amp PCB. Output of the speed sensor can be read across TP1 of the Pre Amp PCB and TP5 of the Logic/Display PCB. Turning the motor shaft slowly should produce a fluctuation between 0 and 5VDC (square wave). The frequency output of the speed sensor can be measured across the same points using an oscilloscope or a multimeter with frequency capability. The speed sensor produces a frequency signal of 1 Hz/5 RPM.

The speed sensor is an integral part of the motor assembly, and is not available separately. If tests to the speed sensor uncover a fault, the motor must be replaced.

Imbalance PCB

The imbalance of the centrifuge motor is controlled electronically through the Imbalance PCB. The Imbalance PCB is located to the right of the motor and does not require calibration. 5 VDC is supplied to the imbalance pcb @ JP3 pins 2 & 3 and connects to the Logic/Display PCB at connector J13. The imbalance PCB is designed to accept a 10-gram imbalance in a fully loaded unit and to give a 'bal' error when there is a 30-gram imbalance.



Failure on the Imbalance Sensor PCB would be indicated by a constant 'bal' error code. Recalibration would require replacement of the Imbalance Sensor PCB.

Replacement of the Imbalance Sensor PCB

1. Remove the front control panel.
2. Remove the rotor and accessories.
3. Disconnect connectors J2 on the Pre-Amp PCB (motor speed sensor), J3 from the Power-Amp PCB (motor windings), and the J13 on the Logic/Display PCB (Imbalance Sensor PCB).
4. Remove the 4 Phillips head screws holding the rotor recognition and the motor boot assembly.
5. Remove the 6 bolts that secure the motor (a 10" extension, with a 5/16" magnetic socket will make this easier. Be careful not to drop the bolts.).
6. Disconnect the ground wire to the motor.
7. Lift the motor out.
8. The Imbalance Sensor PCB is located to the right of the motor and mounted onto the side by a Phillips head screw.
9. Remove the Phillips head screw and replace. Reverse the steps to reassemble.

Motor Blower (in Multi ventilated units only) and Condenser Fan (in Multi R units only)

There is a motor blower in the Multi ventilated centrifuges only, located at the rear of the centrifuge. The condenser fan, found only in the refrigerated units, can be found at the right of the control panel. Both the blower and the condenser fan remain on for an additional 60 seconds after a run or after the compressor cycles off.

Test

1. Remove the front control panel.
2. Plug the centrifuge in and start and stop a run. The blower and fan should stay on for 60 seconds after the end of a run.
3. On the Power Factor Correction PCB confirm that the green LED (DS2) is lit, indicating that the fans should be activated. If it is not, then the problem is most likely within the Power Supply or Logic/Display PCBs.
4. At the Power Factor Correction PCB, measure the 120 VAC going to the blower & fan across J1, pins 3 & 4 (BLK & BLU). Insert multimeter probes into the back of the connector to make this measurement.

Replacing the Motor Blower

Note: The motor blower airflow direction is INWARD, toward the motor.

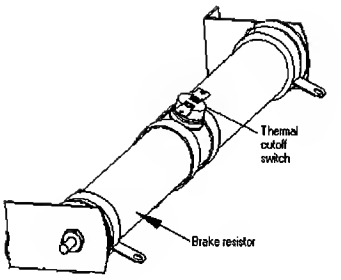
To replace the motor blower for ventilated units:

1. Remove the bezel.
2. Remove the back grill and disconnect the wiring harnesses.
3. Move the unit towards its side or towards the front to get to the underside of the unit.
4. Locate and remove the four bolts that hold the motor blower in place.
5. Slide the motor blower out, replace, and reassemble.

To replace the condenser fan for refrigerated units:

1. Remove the cabinet, and the side panel (the condenser shroud)
2. Locate the condenser fan and bend the whole assembly outward.
3. Detach the condenser shroud from the condenser, by removing the Phillips head screws, to get at the screws holding the condenser fan in place.
4. Straighten the wires to loosen the condenser fan out.
5. Note: ***Pay close attention when rewiring. The brown wire is for the line and the blue wire is neutral.***

Brake



The brake in the Multi series is dynamic. Above 12,000 rpm, windage slows the rotor. From 12,000 to 1,000 rpm, the Drive PCB assembly a switching reversed voltage to the motor. For the last 1,000 rpm, full reverse is applied.

The brake requires service if, with a fully loaded rotor and operating at that rotor's maximum allowable speed, the deceleration time in the brake mode is not less than half of the deceleration time in coast (no brake).

Prior to performing any electrical tests, confirm the resistance of the brake resistors. The brake resistor should measure 50Ω across J2 of the Power Amp PCB. A measurement that significantly differs from 50Ω is an indication that the resistor is 'open', which can negatively affect the brake time. A fully open brake resistor circuit can induce Drive PCB assembly failure. To measure an individual resistor, or change one, requires removal of the cabinet (see Section 8.2).

Thermal Cutoff Switch

The brake system also includes a thermal cutoff switch. This is inline with the main power (the power input) that enters into one side of the switch between the main power switch and the Driver PCB. The thermal cutoff switch senses when the brake resistor is overheating and cuts power off to the unit. The brake resistor can get overheated if it shorted which would mean that there is constant power to the brake resistor.

Test

Use this procedure to verify function of the braking system:

1. Remove the front control panel.
2. Remove the PC Board barge by removing the 4 Phillip screws.
3. On the Power Amp PCB, locate TP1 (+HV) and TP2 (HV GND).
4. Plug the unit in and verify that a properly loaded rotor is installed.
5. Select an appropriate speed and time, and start a run.
6. During the brake phase, between 12,000 and 5,000 rpm, verify DC braking voltage across these test points. Expected measurement should be approximately 400 VDC. (Typical standby measurements should read 300 VDC.)
7. If voltage is not present, verify resistance of the brake resistor at J2 of the Power Amp PCB. The expected value is approximately 50Ω.
8. If the resistor measurement is as expected, replace the Driver Board Assembly.

To remove the brake resistor:

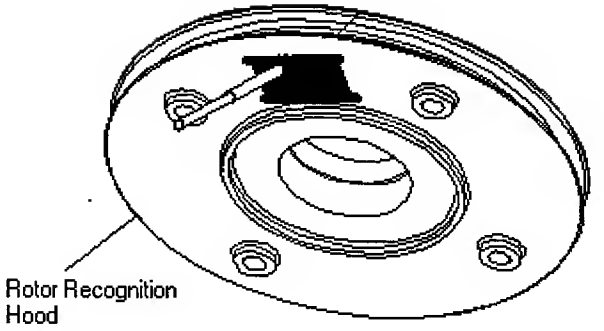
1. Remove the cabinet assembly.
2. Remove the two bolts that hold the brake resistor onto the brackets.
3. Unplug the thermal cutoff switch.
4. Remove the brake resistor, replace, and reassemble.

Rotor Recognition System

The rotor recognition is comprised of the following components:

- Rotor recognition ring (mounted on rotor).
- Rotor recognition hood (part of motor boot).

The rotor recognition ring is an integral part of the rotor assembly. Repairs to it can only be made at the factory. Contact IEC directly for any such repair. Each model rotor contains a unique pattern of magnets which, when the rotor turns, are sensed by the rotor recognition hood. A Hall effect type sensor embedded in the hood 'picks-up' the rotor's 'fingerprint'.



If you experience a rotor recognition error code (Err 14), there is software built in to help diagnose the problem. A diagnostic beeper can be turned on to indicate every time the rotor recognition hood sensor detects a magnet (located in the rotor recognition ring of the rotor). Turning the rotor slowly by hand, once this beeper is activated, should produce the appropriate number of beeps as listed in the following table. An absence of beeps may indicate that a magnet is dirty or damaged, the gap between magnet and sensor is too large, or that the rotor recognition hood (located in the motor boot) is defective.

There are six rotors available for use in the Multi Series. Each has its own 'fingerprint' by which the rotor recognition system identifies it. The following table indicates the fingerprint for each rotor. Remember, this fingerprint is heard properly when the rotor is turned one full revolution, in the direction of rotation, i.e. counterclockwise.

Thermo IEC Rotor No.	Description	Fingerprint Diagnostic Beeps.
8244	DoubleDeep Microplate	5-1-1-2-1
8685	6x85ml Fixed Angle Aluminum	4-3-3
8848	48x1.5ml Microtube	4-5-1
8850	8x50ml Conical	4-4-2

To activate (and deactivate) the diagnostic beeper:

1. Press the hidden button (located below the **MANUAL** button).
2. Press the **PROGRAM** button repeatedly until time & program displays read **bEEP & OF**.
3. While the display is dim, press **3-0-0-ENTER**, to toggle the program display to **on**.
4. If the display is bright, you must press **PROGRAM** until the display reads **bEEP again**, and press **3-0-0-ENTER** before the display returns to bright.
5. Press the hidden button to exit this special function menu.

Refrigeration

General

The refrigeration system of the Multi-R is capable of maintaining a 4° C guard bowl temperature at ambient temperatures up to 23° C. The unit should be able to maintain this temperature within ± 2° C of the set point.

- The Multi-R features a 1/2 hp nominal compressor. It uses 11.5 oz. of R-404A refrigerant for low voltage models and 10.5 oz. For high voltage models. Operational pressures are approximately 225 psi on the high side and 20 psi on the low side. The compressor has a 90 second delay before restarting.

In manual mode, refrigeration, if required, will operate when the unit is on and the lid is closed. In program mode, refrigeration will only operate if the program requires cooling and the start button is pressed.

Both refrigerated and ventilated models require ventilation for proper airflow. Allow a minimum of 8 cm (3 inches) clearance on all vented sides of the unit. Insure that the condenser fins and ventilation grill are free of dust and dirt. Do not operate the refrigeration system, if the condenser fan is not working correctly.

The compressor in the refrigerated unit is controlled by a solid-state relay. The solid-state relay acts as a switch, which receives a low voltage signal (5VDC) from the Logic/Display PC board to either turn them on, or off. The signal originates at the Display/Logic PC board and passes through the Power Supply PC board which then supplies the low voltage and low current signal to the solid state relay coil. The relay contact is then made, providing 120VAC to the compressor, thus turning them on. If the 5VDC signal from the Power Supply PC board or the Display/Logic PC board is lost, the compressor will shut off.

Condensing Unit

Only qualified personnel with the proper refrigerant recovery systems should perform service on the condensing unit.

The condensing unit consists of the compressor, the condenser, condenser fan and their related electrical components.

Test

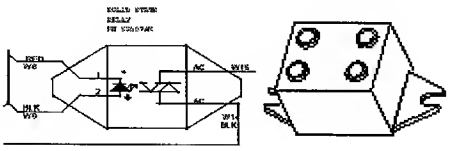
Use the following procedure, to verify voltage to the compressor:

1. Verify function of the Solid State Relay.
2. Remove the front control panel.
3. Disconnect the solenoid harness at J2 of the Power Factor Correction PCB.
4. Remove the Power Factor Correction PCB from the cabinet (5 screws), leaving the wiring harnesses connected, and let it rest on the base of the centrifuge.
5. Disconnect the proximity switch harness at the switch and jump out these two leads (WHT & WHT). (This will allow the refrigeration unit to be started with the cabinet removed.)
6. Disconnect the latch microswitch leads at the latch assembly and jump out these two leads (WHT & BLK). (This will allow the refrigeration unit to be started with the cabinet removed.)
7. Remove the cabinet assembly.
8. Locate the electrical box of the condensing unit and remove the cover by removing the C-clip holding it in place.
9. Plug the unit in. {If you have the centrifuge in manual mode, and have the cover closed (switches shorted) the refrigeration system should be activated by setting a temperature below ambient. If the COMP LED does not come on, check the Logic PCB.}
10. Use a voltmeter to measure the AC voltage across the BLU and BLK wires at the connector just before the compressor electrical box.
11. The voltage applied to the compressor should be line voltage (except models 6468, where it is 115 VAC).
12. If voltage is present, but the compressor does not start, check the starting capacitor.
13. If voltage is not present and the COMP LED on the Power Supply PC board is lit, check the solid state relay (see Section 12.3) and/or the Power Factor Correction PCB.

14. Reassemble the unit by reversing these steps. Use the Wiring Diagram as a guide for reconnecting all the harnesses.

Refrigeration Relay

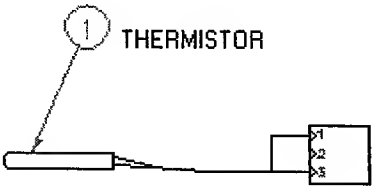
The solid-state relay (SSR) powers the compressor on a low voltage signal from the Power Factor Correction PCB. The SSR is located to the right of the control panel. Access to the solid-state relay is by removing the right side panel. To test the SSR, use the following procedure:



1. Remove the front control panel.
2. Remove the 4 Phillip screws on the right side of the cabinet to get access to the Solid State Relay.
3. Plug in the centrifuge and start a run with a set temp. Lower than ambient.
4. When the refrigeration system is activated (COMP LED on Power Factor Correction PCB - DS3 green - is lit), there should be 5 VDC present across the GRY & RED wires on the SSR. If not, check the connections back to the Power Factor Correction PCB and replace the Power Factor Correction PCB if necessary.
5. If the 5 VDC is present, verify the voltage output of the SSR. Line voltage should be measured across the two BLK leads on the SSR. If line voltage is not found replace the relay.

Thermistor

The thermistor is located inside the chamber of the refrigerated units (Multi-R). It is secured by a rubber grommet and is sealed into the foam below the chamber using RTV (silicon sealant). You can verify its operation by taking its resistance at various temperatures. Follow this procedure to do so:



1. Remove the front control panel.
2. Locate J6 connector on the Logic/ Display PC board and disconnect it.
3. Measure the resistance across pin 1 (YEL) and pin 3 (YEL) on the harness.

- At 25° C (approx. room temperature) the resistance should be 2.25 kΩ.
- At 0° C (achieved by packing ice around thermistor) the resistance should be 7.35 kΩ.

If these values are not verified, or if an open or short circuit is detected, the thermistor should be replaced.

Replace

Use the following procedure to replace the thermistor:

1. Open the cover.
2. Remove the front control panel.
3. Locate the thermistor inside the bowl, toward the front of the unit.
4. Remove the tape and any RTV (silicon sealant), which supports the thermistor inside the foam.
5. Push the thermistor down through the rubber grommet and out the bottom of the evaporator foam assembly.
6. Install the new thermistor in the same manner so that the bottom of the sensor is flush with the bottom of the foam. This will position the sensor height at 0.2" to 0.625" above the guardbowl surface.
7. Reseal the thermistor in place using RTV. This will prevent any movement of the thermistor, as well as preventing any condensation from forming.

Pressure Switch

The refrigerated units (Multi-R) also include a pressure switch. This pressure switch acts as a safety device for the refrigeration system. The pressure switch is brazed into the high-pressure tubing run between the compressor and the condenser. If the pressure in the refrigeration system exceeds 500 psi, the pressure switch will 'open', shutting the compressor off.

Only a qualified refrigeration technician should replace the pressure switch.

Troubleshooting

BAL indicates that there is an imbalance.

- Unplug the unit then plug the unit back in to clear the error message.
- Remove the buckets and the adapters and operate the unit with only the rotor.
- If the unit runs with no vibration,
    - Lubricate the archway of the buckets with IEC Molykote (p/n 7133) lubricant, where the buckets rest on the rotor.
    - Verify gram weights of buckets and adapters with a digital scale.
    - Install matching gram weights opposite each other to within 1 gram.
    - If the unit vibrates with only the rotor installed, check the motor and the motor mounts, the rotor should be sent in to IEC for evaluation if everything else appears to be ok.

HEAd indicates that either (1) no rotor is installed when the START key is pressed, or (2) that the rotor recognition system failed to read the valid rotor number (ID). When this error appears, press STOP to clear the error.

- Remove the rotor.
- Look at the underside of the rotor for loose, missing, or defective magnets.
- Confirm or clean the rotor magnets to ensure a good contact with the rotor recognition system.
- See Diagnostic Beeper. Section xxx

Ch hd indicates Change Head. This means that the rotor recognized is not in the list of supported rotors, or in the Program mode, and the current Program is set up to run with a different rotor.

- Press STOP to erase this message.
- Open the cover.
- Install the appropriate rotor.

Lid appears when the START key is pressed, and the cover is not closed. Close the cover to erase this error code. If the Lid still appears, then unplug the unit and plug the unit back in to clear the message.

- Open the cover.
- Remove the front control panel.
- Check the resistance across the microswitches at J1 from the Logic/Display PCB.
- When the lid is open, the switches should read open. If the lid is closed, switches should read closed.
- If the readings are not as expected, verify by measuring the switches directly.
- The switches may be adjusted slightly by loosening its mounting screws, holding it in place, and re-tightening the screws. The actuator arm of the switch may also be adjusted to improve performance.

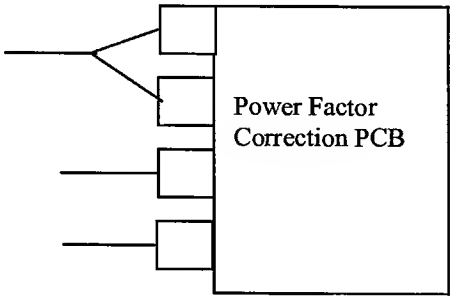
PFAIL indicates that power was interrupted during a run. This message appears when the unit is turned back n, following the failure. The front panel will alternate between the PFAIL message and the remaining run time, or elapsed time, if in HOLD mode. Press STOP, to erase the message, and press START to resume the previous run.

- If PFAIL still occurs, check the inline voltage.
- Measure to see if there is noise in the line.
- If there is no noise, and if the PFAIL appears when the unit is in a run, check the brake resistor.
- PFAIL could indicate that the Thermal Cutoff Switch for the brake resistor has sensed that the brake resistor is overheating.

COOL indicates that temperature of the Mosfets that are on the PC board may of exceeded 65 C., which will cause the unit to coast to a stop. This may be caused by the same factors for errors causing ERR 1

Err 1

- Check for any visible damage on the PC boards
- Remove the barge assembly to attain access to the PC boards
- Check fuses, verify that none are blown
- Check the LEDs on the Power Factor Correction PCB
- If not all LEDs are functioning properly, measure the mosfets from the Power Factor Correction PCB
  - The mosfets are in parallel.
  - Ground one terminal
    - 1 MΩ- Good
    - <500kA- Bad, replace PCB



- If all LEDs on the Power Factor Correction PCB are working properly, the Pre-Amp PCB on the Driver Board Assembly may be bad. Replacement requires replacement of the entire Driver Board Assembly.

Err 14 Incorrect Rotor Signatures

The rotor signature detected does not correspond with the database of rotors.

- Test the fingerprinting.
- Hidden button located underneath 'SPEED', towards the left.

FSAFE, COPF, COP

- Result of possible noise on power line.

REVISIONS				
REV	BY	ECO	APPROVED	DATE
0	RRE	5558	RRE	09/11/00
1	RAE	5549	CI	11/12/00
2	HJR	5785	CI	4/10/01

PEM 51063
GND
N L
W2 BLU
W3 BRN
120 VAC INPUT
E01
CHASSIS - ACCESSIBLE PART
20 AMP POWER SWITCH/ CIRCUIT BREAKER P/N 51233C
W2 BLU
W3 BRN
W4 BLU
W5 BRN
POWER HARNESS PN 51212
FILTER PN 62607
LINE
LOAD
BRN W5
BLU W4
W1
W2
TERMINAL BLOCK HARNESS PN 51330
4 POS TERM STRIP
W1
W4
W4
W3
W3
W2
W2 BRN
W4 BRN
W13 BRN
W10 BLU
W3 BLU
W1 BLU
W12 BLU
RELAY P/N 51292
K1
NO
COM
T91S1D52-12
W11 BRN
W5 BRN
W4 BRN
W6 WHT
W7 YEL
W5 AND W3 ARE NOT USED - SECURE W/ TIE WRAPS
BRN W5
BLU W3
MAIN HARNESS PN 51319
ISOLATED SECONDARY
44495 IMBALANCE DETECTION PCB
J1
IMBALANCE HARNESS PN 51322
TO LOGIC PCB
GROUND WIRE PN 40037
G/Y
E02
MOTOR SHAFT - ACCESSIBLE PART
MOTOR PN 51177
W3
W5
W2
PI - LOGIC
51353 BOARD MODULE ASS'Y
BRAKE RESISTOR PN 51334
W2
YEL
W1
W22 BRN
Thermal Switch PN 51365
W2 BRN
ISOLATED SECONDARY
ROTOR RDC RD ASSY PN 51066
CONDENSER FAN
L
N
PE
PE
BRN W11
BLU W10
P/N 51376
COVER SOLENOID PN 506340R
COVER SOLENOID PN 506340R
WHT
WHT
WHT
WHT
WHT
WHT
WHT
W22BRN
W1 BLU
W9 WHT
W8 RED
W7 YEL
W6 WHT
J8
J2
J9
PFC POWER SUPPLY p/n 51289
J7
J5
120 VAC INPUT
J3
T2
REINFORCED INSULATION FOR 170V PK
J10
PI, PRIMARY I, 170 VPK
PII, PRIMARY II 300 VDC NOMINAL
PII - 300 VDC
DC BUS HARNESS PN 51329
W2 RED
W1 BLK
J1
J2
POWER AMP BOARD PN 51302
PRE- AMP BOARD PN51367
J3
WHT W3
W5 RED
W2 BLU
PII - 300 VDC
J2
GRY
ORN
BRN
BLU
YEL
PI - LOGIC
J1
J6
W1 YEL
W2 YEL
HARNESS PN 51361
PII - 300 VDC
BRAKE HARNESS PN 51321
PI - LOGIC
J4
J6
W9 W8 W7 W6 W5 W4 W3 W2 W1
BLK
W10 WHT
W7 WHT
PROXIMITY SENSOR PN 51064
TO IMBALANCE PCB
LOGIC / DISPLAY HARNESS PN 51318
LVPS HARNESS PN 51362
J5
J12
LOGIC/DISPLAY BOARD PN 44498
J7 AND J10 NOT USED
J13
J8
J6
RS232 HARNESS PN 51368
GROUND HARNESS PN 51369
ISOLATED SECONDARY
OPTOCOUPLER ISOLATION 8 PLACES
J1
J2
J4
J3
J9
BLK
GRY W2
GRY W1
GUARD BOWL THERMISTER PN 65692
COVER SW HARNESS PN 51339
ACCESSIBLE PART - REINFORCED / INSULATED / ISOLATED
MEMBRANE PANEL PN 51261
GRY W1
GRY W3
NC
NO
C
COVER SWITCH
GRY W3
GRY W2
NC
NO
C
COVER SWITCH
PRESSURE SWITCH PN 50610
BLK
BRN W13
BLK
BLK W14
SOLID STATE RELAY PN 55597AR
RED W8
BLK W9
AC
AC
W15 BLK
W16 G/Y
W14 BLK
W12 BLU
E03
J/P12
BLK W17
W18
W19 BLU
G/Y
W18 G/Y
W20 BLK
W21 BLU
W20
W21
PFC CAPACITOR 51325A
COMPRESSOR
START CAPACITOR
PROTECTOR
BLK
BLK
BLK
C
S
R
E04
START/RUN RELAY
S
M
1
2
BLU

ThermoIEC
300 SECOND AVE
NEEDHAM HGHTS, MA. 02194

Title: IEC - MP System schematic / Refrigerated

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